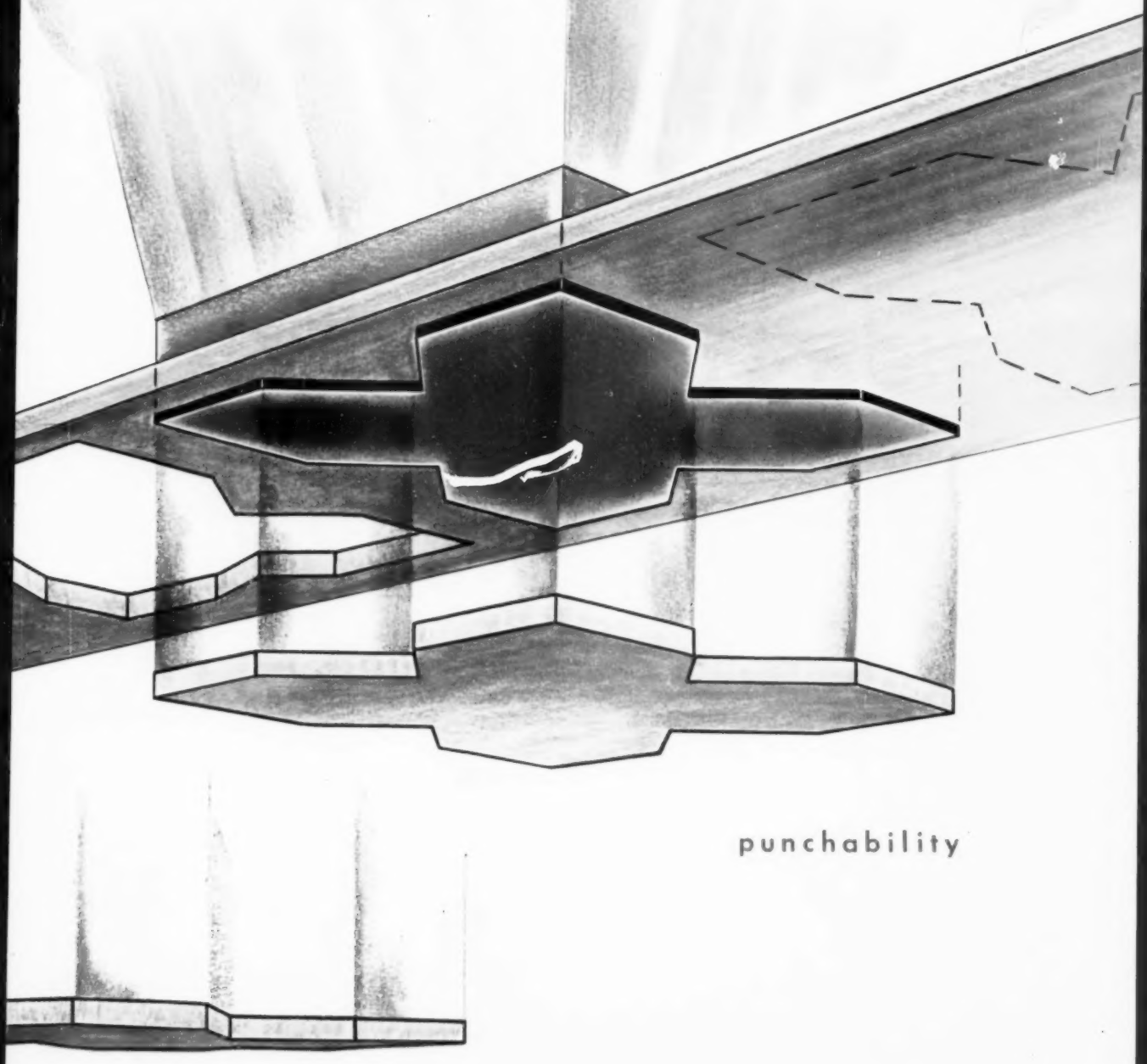
the

TOOL ENGINEER

DECEMBER 1958



punchability

PUBLICATION OF THE AMERICAN SOCIETY OF TOOL ENGINEERS

it's mainly a matter of TIMING!

When an old machine costs you more than it earns, replacement pays for itself!

There comes a time in the life of any machine, when it will no longer produce at a profit — a time beyond which its continued use represents a *financial loss* to your company. This point of obsolescence may be the result of physical aging or of technological advances. In either case, the result is the same — money wasted that could be *saved* by the investment in a new machine.

Determining *when* to replace a machine is too important for guesswork or rule-of-thumb computations. Only precise methods of comparative cost analysis will give you the right answer. Our sales engineers are well experienced in making obsolescence studies and will be glad to do the same for you. Similar studies have pointed the way to many important savings.

For Example: A manufacturer of aircraft instruments had been using a 5-year-old precision lathe to perform boring, turning and facing operations on instrument cases. But when this was replaced with a new Heald Model 0 Unit-Type Bore-Matic like that shown at the right, operating costs for the same production were immediately reduced by over 78%. In addition, the elimination of a separate burring operation and reduced assembly time made further important savings, as indicated by the cost analysis below.

	Old Machine	New Machine
Parts per hour	4.3	20
Parts per year (Req'd. Prod.)	10,000	10,000
Direct and Indirect Labor, per year	$20,349	$ 6,055
Scrap Losses, per year	$ 500	$ 300
Annual Maintenance Cost	$ 600	$ 300
Annual Operating Cost	$21,449	$ 6,655
Basic Annual Saving, New Machine		$14,794
Additional Saving from elimination of separate separate operation		$ 500
Additional Saving from reduced assembly time		$ 1,500
Total Saving Per Year		$16,794
Return on Investment for New Machine		84%

YOU pay for obsolescence. Replacement pays for itself!

THE HEALD MACHINE COMPANY

Subsidiary of The Cincinnati Milling Machine Co.

Worcester 6, Massachusetts

Chicago • Cleveland • Dayton • Indianapolis • New York

HEALD

the tool engineer

Vol. 41, No. 6 December 1958

Successful Quality-Control Operations ..... *By Edward S. Marks* 39
Inspection and measurement are only one phase of quality control operations. Sound over-all planning is equally important.

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Fixture for drilling center holes, end driving adapter for grinding, clamp for irregular stock, pressing fixture, master drill bar.

Building-Block Designs Reduce Tooling Costs ..... *By Ralph E. Cross* 47
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With the provision of mechanical tool changing for numerically controlled boring machines, fully automatic production is possible.

Improving Punchability of Silicon Steel ..... *By C. S. Wukusick and R. S. Zeno* 63
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Tilting Solves Piercing Problem ..... *By H. A. Sygnator* 76
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Superalloys Formed with Explosives ..... *By Paul J. Wolf* 78
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Numerical Control or Tracer Control? ..... *By Fred W. Burdett* 83
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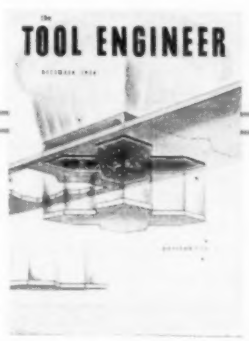
THIS MONTH'S COVER

Life of punches such as the one illustrated is determined by the combination of punch material and work material used. The effects of these variables—and several ways to increase punch life—are covered in the article beginning on page 63. Cover artist is William Solms.



THE TOOL ENGINEER is regularly indexed in the *Engineering Index Service* and *Applied Science & Technology Index.*

STARRETT PRECISION MAKES GOOD PRODUCTS BETTER

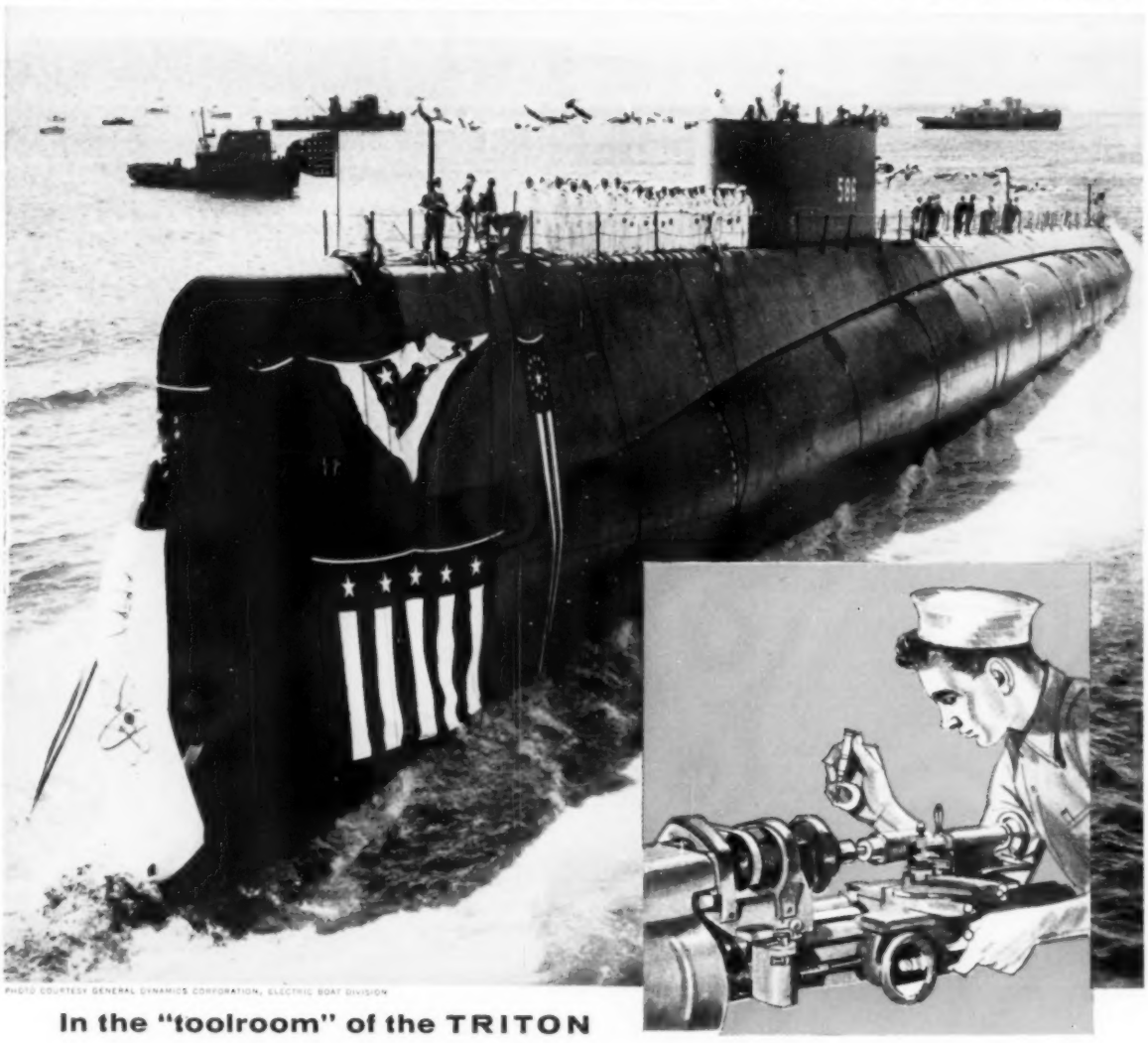


PHOTO COURTESY GENERAL DYNAMICS CORPORATION, ELECTRIC BOAT DIVISION

In the "toolroom" of the TRITON

STARRETT PRECISION MEASURING TOOLS

In the sea-going machine shop aboard the *Triton*, newest and largest atomic-powered submarine, STARRETT precision measuring tools will help maintain the 447-foot, twin-reactored craft on long undersea voyages.

STARRETT tools also helped set the precision standards that made it possible for over 500 companies across the nation to contribute to the building and fitting out of the *Triton*.

In the toolrooms of these companies, on the production lines, on the inspection benches and in the personal kits of skilled mechanics, STARRETT mechanics' hand-measuring tools and precision instruments made it easy to be accurate, sharpened skill, kept constant watch over quality and precision.

The L. S. Starrett Company and Starrett Distributors everywhere salute the *Triton*. We are proud to have played a part in equipping her.

STARRETT precision measuring tools, dial indicators, dial gages, steel tapes, steel rules, hacksaws, hole saws, band saws, band knives and precision ground die and flat stock are always available through a convenient and reliable source of supply — your nearby Industrial Supply Distributor. Write for Starrett Complete Catalog No. 27. Address Dept. E, The L. S. Starrett Company, Athol, Massachusetts, U. S. A.

Starrett®
PRECISION TOOLS
World's Greatest Toolmakers

PRECISION TOOLS • DIAL INDICATORS • STEEL TAPES • GROUND FLAT STOCK • HACKSAWS • HOLE SAWS • BAND SAWS • BAND KNIVES

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Do It Yourself!

When production equipment is needed, many successfully outsanding companies never build anything for which there is a satisfactory commercial product. Engineering time is considered too valuable to waste on duplication of effort. Furthermore, an available product, whether it be a complete machine or a component, has been debugged and proved by applications.

Who would consider building an electric motor or a roller bearing for a standard type of application? The commercial product is far superior to anything that could be built at the same price. Misapplications of such standard components are few and far between. In fact, when one does occur, the parts manufacturer is seldom blamed. His reputation remains unscathed.

With the advent of built-in functions on machines, manufacturers of equipment such as gages have developed "do it yourself" components that may be built into the control. Even though these components were designed and built as dependable precision parts, they occasionally fail to function through misunderstanding resulting in misapplication. Then, the parts builder may fear that his reputation is in jeopardy.

In a field growing as fast as tool engineering, the component manufacturer should not overlook the ingenuity and contributions of the tool engineer. Throughout many plants there are Rube Goldbergs and gadgets that are working well. The components are applied in ingenious ways. Once in a while there is a bad application. Both types, however, add to the fund of information rather than detract from it.

The component manufacturer and the tool engineer are truly partners in progress. This is American know-how at its best.

John W Greve

EDITOR

Bowling Equipment Manufacturer Switches To Molds Made With

POLYTOOL Epoxy Tooling Compounds

The molds used to form the "Fairlane" bowling alley equipment produced by the M. Blatt Co., Trenton, N. J., formerly chipped and cracked when molded parts were removed. They needed replacement after a single year's service. Now, the same molds are being constructed with RCI POLYTOOL epoxy tooling compounds.

"After six months of heavy usage," says Mr. Louis Tavani, shop foreman, "our first epoxy mold is free of any chipping or cracking. We now expect molds made with the RCI epoxy compound to last at least 5 years!"

These RCI epoxy materials promise any company greater mold durability, which means big savings on production costs. Greater dimensional stability and resistance to shrinkage are other important features you'll find in RCI POLYTOOL epoxy compounds.

The actual finished products derived from these Blatt Company molds (such as the bench shown above) are constructed of RCI POLYLITE polyester resin reinforced with glass cloth. The coloring comes from an RCI gel coat that is applied to the mold first.

The M. Blatt Co. constructed their first epoxy mold with the help of a Reichhold technical representative skilled in the use and performance of POLYTOOL compounds.

Why not write RCI for full details on the profit-potential of POLYTOOL epoxy tooling compounds and POLYLITE polyester resins in *your* application?

REICHHOLD

Synthetic Resins • Chemical Colors • Industrial Adhesives • Phenol
Hydrochloric Acid • Formaldehyde • Glycerine • Phthalic Anhydride
Maleic Anhydride • Sebacic Acid • Ortho-Phenylphenol • Sodium Sulfite
Pentaerythritol • Pentachlorophenol • Sodium Pentachlorophenate
Sulfuric Acid • Methanol

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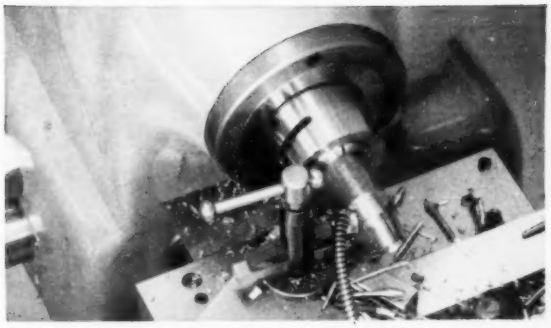
RCI BUILDING, WHITE PLAINS, N. Y.

Creative Chemistry . . . Your Partner in Progress

RCI

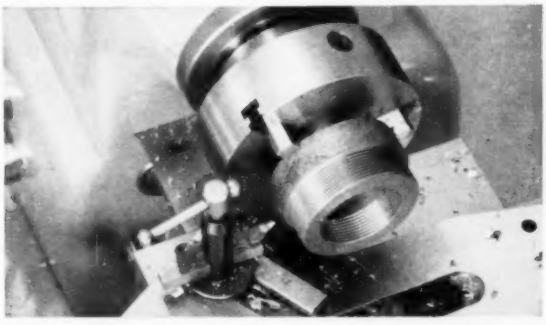
HARDINGE
ELMIRA, N.Y.

"The Outstanding Tool Room Lathe"



Precision Collet work for all sizes to 1 – 1/16" Collet seats *directly* in spindle.

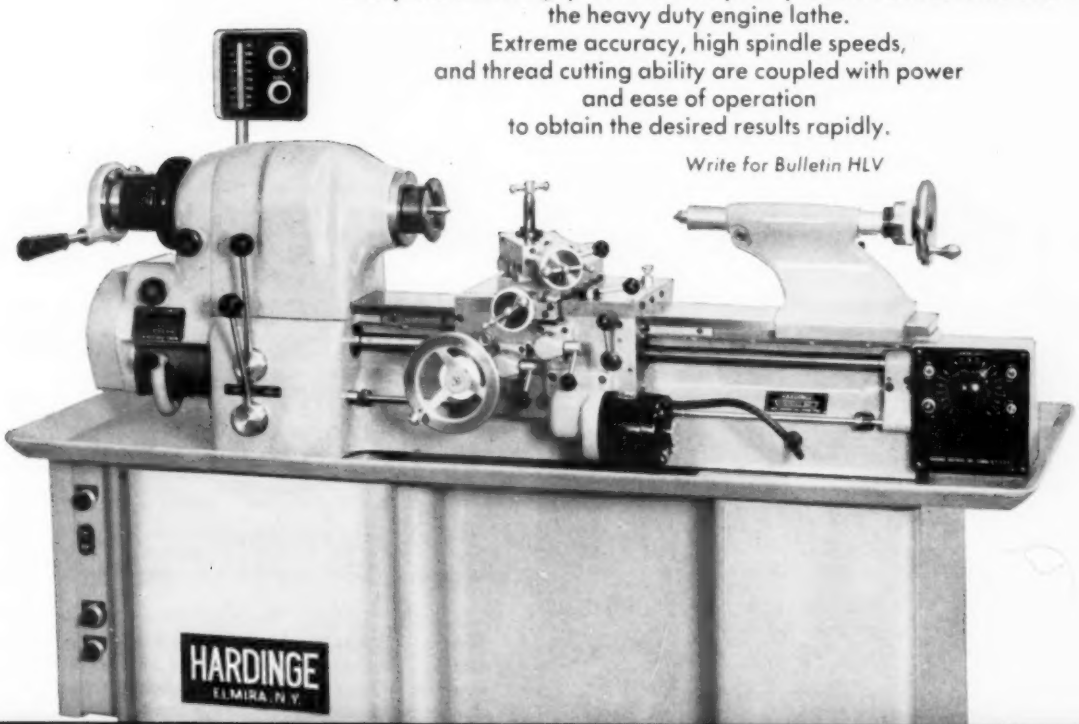
Precision Step Chucks for diameters up to 6". Provides Collet-like accuracy.



Integral Mount Jaw Chucks for precision holding of regular or irregular shapes up to 5".

Hardinge Model HLV 10" Lathe was primarily designed to fill a very old existent gap between the plain precision bench lathe and the heavy duty engine lathe.
Extreme accuracy, high spindle speeds, and thread cutting ability are coupled with power and ease of operation to obtain the desired results rapidly.

Write for Bulletin HLV

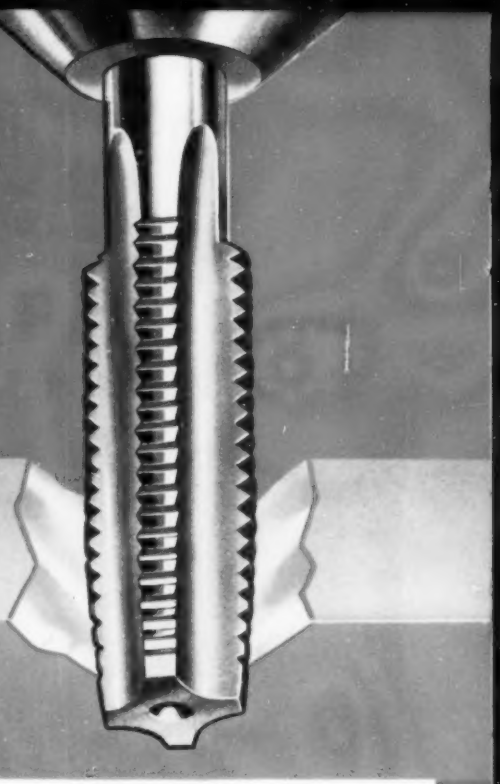


HARDINGE BROTHERS, INC., ELMIRA, N. Y.

OFFICES IN PRINCIPAL CITIES. Export Office: 269 Lafayette St., New York 12, N. Y.

4 Reasons

why you get greater accuracy and uniformity of tapped holes with BALANCED ACTION



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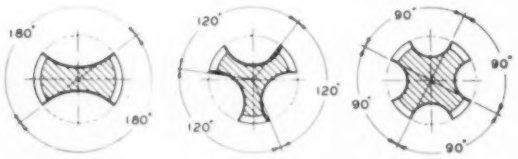


EXACT FLUTE SPACING

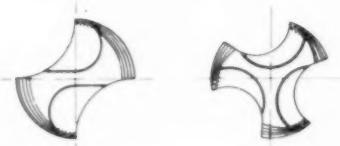
A prerequisite to exclusive Balanced Action performance, flute spacing determines the balance of the tap. Winter achieves exact spacing through precise indexing.

2

UNIFORM FLUTE CONTOURS

Another element of Winter design "teamwork", uniform flute contour is an integral part of Balanced Action. Controlled flute contours are vitally important to proper tapping of specific materials.

3



PRECISION CHIP DRIVER CONTOURS

To eliminate inaccuracies of off-hand grinding and polishing, Winter designed and built special machines to assure perfect chip-driver contours.

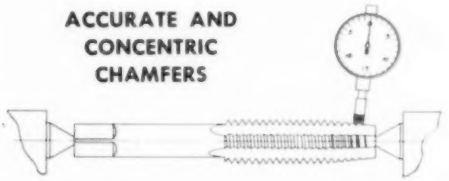
WINTER

CALL YOUR DISTRIBUTOR for standard and special WINTER Balanced Action Taps, Dies, and Gages.

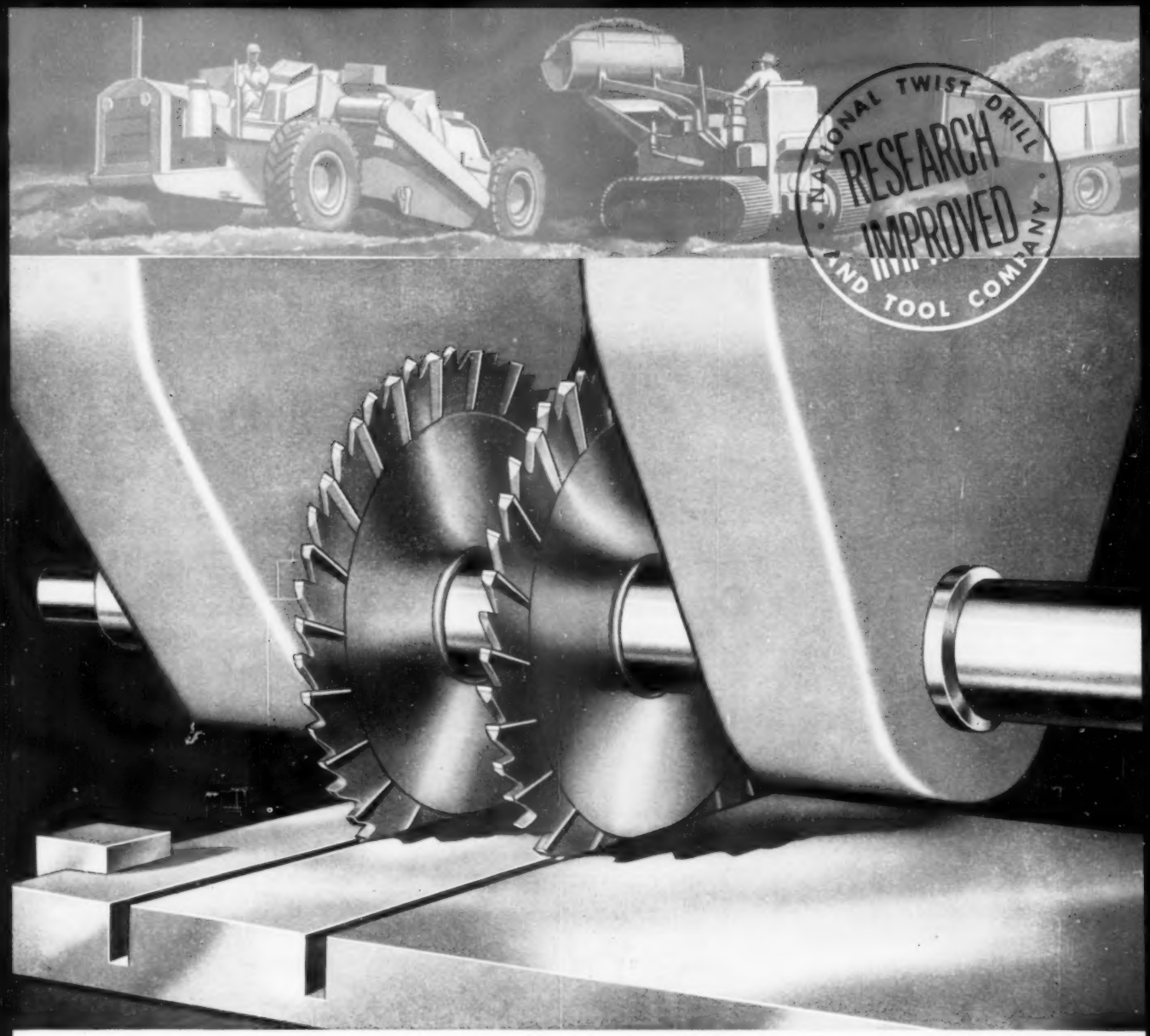
WINTER BROTHERS COMPANY, Rochester, Michigan, U.S.A. Distributors in principal cities. Branches in New York • Detroit • Chicago Dallas • San Francisco • Los Angeles • Division of National Twist & tool Co.

4

ACCURATE AND CONCENTRIC CHAMFERS



The last—but not the least—important element of Balanced Action, accurate and concentric chamfers eliminate tap run-out. Winter holds shank, chamfer and thread concentricity to remarkably close limits.



increase your cutting efficiency

with research improved National metal slitting saws

National metal slitting saws give you the edge for tool room or production work because they're job-engineered to minimize binding and scoring. Made of the finest quality high-speed steel for long life, National saws are available in a wide range of diameters and widths to do a variety of operations—including multiple slotting, grooving, slitting, cutting off—efficiently and economically.

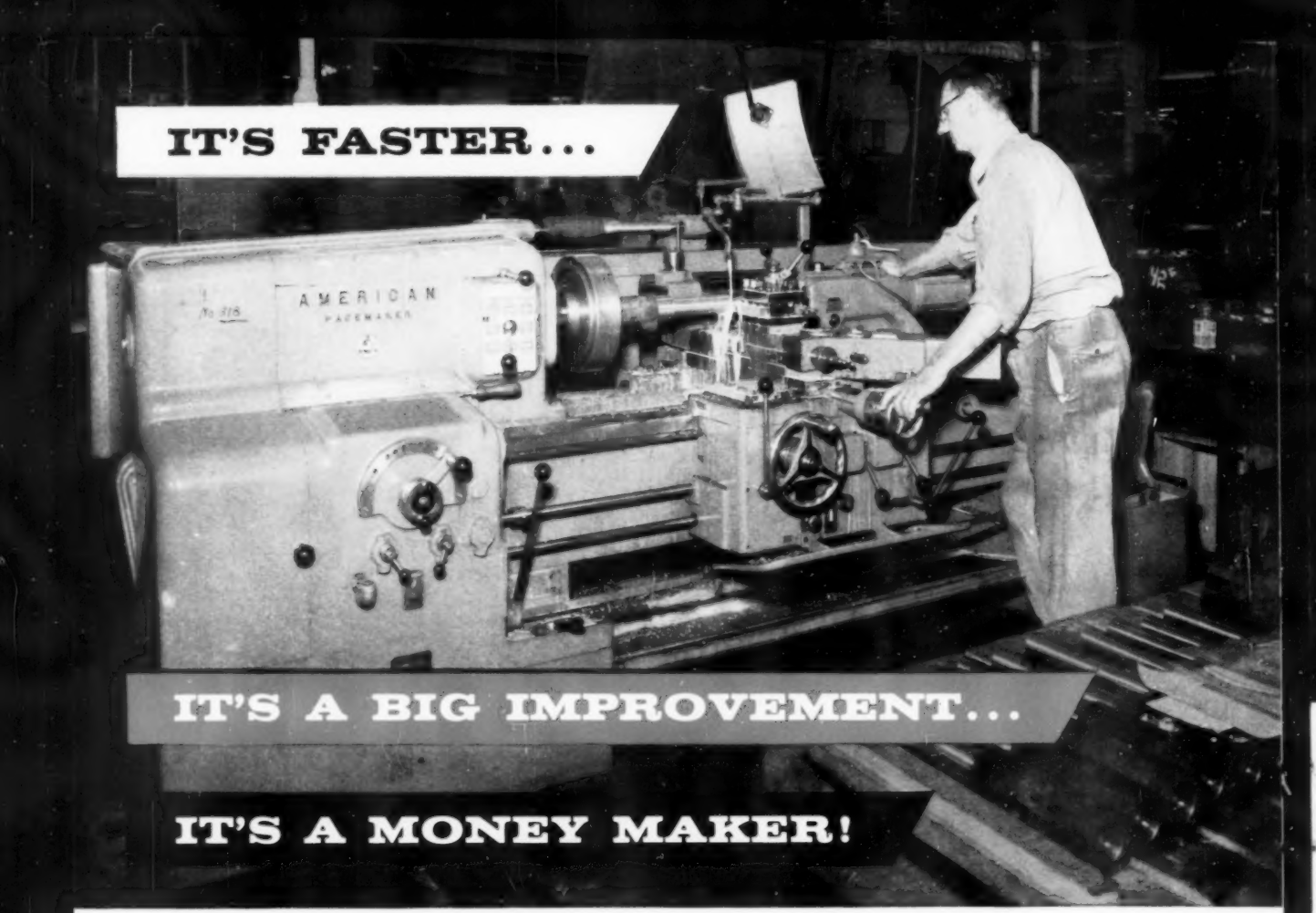
CALL YOUR DISTRIBUTOR for NATIONAL twist drills, reamers, counterbores, milling cutters, end mills, hobs, carbide and special tools.

National

NATIONAL TWIST DRILL AND TOOL COMPANY

Rochester, Michigan, U.S.A.

Distributors in principal cities. Branches in New York • Detroit • Chicago • Dallas San Francisco • Los Angeles



These are exact words from the production officials of The Cleveland Worm and Gear Company, of Cleveland, Ohio, which company produces the universally known and widely used Cleveland Worm Gear Speed Reducers.

The machine to which they refer is their new "AMERICAN" DeLuxe Model Hydraulic Duplicating Lathe. This lathe, as the illustration shows, is used primarily for machining worm forgings from a round template.

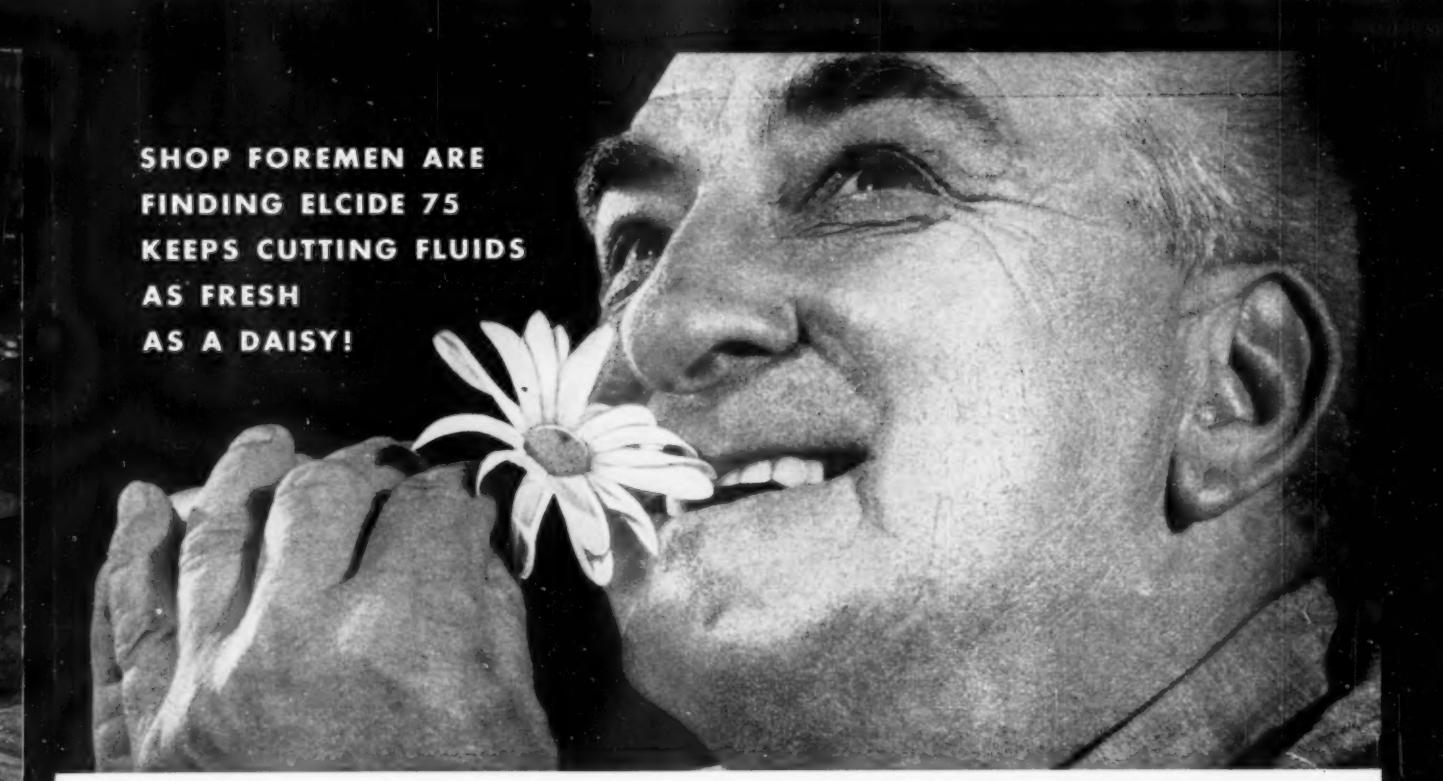
Accurate duplication of parts, high speeds, heavy cuts, plenty of power, quick acting air operated tailstock and ease of operation are the major characteristics contributing to the amazing productivity of this machine.

More production per man hour is the answer and only answer to spiraling costs—modern, high production machinery is the answer to greater production per man hour. Judging from reports, The Cleveland Worm and Gear Company has found this to be true.

Bulletin No. 135 gives a complete description and shows many examples. It's yours for the asking.

THE AMERICAN TOOL WORKS CO. Cincinnati 2, Ohio, U. S. A.

LATHES AND RADIAL DRILLS



You have less down time when you treat emulsions with new ELCIDE 75™

One ounce of Elcide 75 per each four gallons of standard duty soluble oil emulsion controls the harmful bacteria that shorten emulsion life. In one shop test, emulsions treated with Elcide 75 lasted 5½ times longer than untreated emulsions!

Longer emulsion life means less down time and more efficient use of labor. The time lost on recharging emulsions is greatly reduced, and so is the size and expense of disposal problems.

Extended shutdowns are less of a problem when emulsions are treated with Elcide 75. Since Elcide 75 can be safely stored for long periods, some plants have found a reserve supply is extremely useful as protection for emulsions during extended shutdowns such as vacations and inventories.

Plant efficiency is increased several ways. Elcide 75 controls bacteria that may cause staining and corrosion. It is safe and nontoxic to employees, and its antibacterial action eliminates objectionable odors.

Elcide 75 effectively controls bacteria that cause odor, staining, corrosion, and emulsion breakdown because it is a *combination* of two powerful antibacterial agents. It includes a powerful new compound related to one of the safest and most effective bacterial inhibitors used in the exacting field of medical surgery. Elcide 75 covers a much wider range of bacteria than the single inhibitors commonly used in emulsions today.

PRODUCT SPECIFICATIONS ELCIDE 75

Active Ingredients—Sodium Ethylmercuri Thiosalicylate (Thimerosal) and Sodium *o*-phenylphenate.

Package	Price per Gal.
1-gallon polyethylene	$8.50
5-gallon polyethylene	$8.00
55-gallon stainless steel	$6.50

Sold only through selected distributors.

Lower your operating costs. If you use standard duty soluble oil emulsions, Elcide 75 can save you money. Production goes up as costs go down. The reduction in total soluble oil purchases can more than pay for the cost of using Elcide 75. Why not try Elcide 75 in your plant operation soon?

For more information or to place your order, write or phone:

ELCIDE 75™

PATENT PENDING

Lilly

Lilly's brand of bacterial inhibitor for cutting fluids

ELI LILLY AND COMPANY, AGRICULTURAL AND INDUSTRIAL PRODUCTS DIVISION; INDIANAPOLIS 6; INDIANA. TELEPHONE: MELROSE 6-2211

Automation for Low Volume Production

Operation 260—Four-Way Machine—reams dipstick hole; finish reams valve lifter holes; reams 7 holes in rear end; taps 1 hole in top.

Operation 250—Four-Way Machine—taps 6 holes in rear, 22 holes in front, 10 holes in each bank, and 6 holes in top.

Operation 240—Three-Way Machine—drills dipstick hole; drills angular hole in top; reams dowel holes in front end; drills 2 holes in front end.

Operation 230—Three-Way Machine—reams dowel holes in banks; drills and chamfers 3 holes in top; end mills dipstick hole.

Operation 220—Four-Way Machine—taps left side; taps left underbank; drills miscellaneous angular oil holes.

Operation 210—Four-Way Machine—taps right side, right underbank, pan holes, bearing cap bolt holes, and 9 holes in front end.

Operation 200—Five-Way Machine—reams 6 holes in underbanks; reams 1 hole in front end; drills 2 angular oil holes; taps 1 angular hole in pan face.

Operation 190—Five-Way Machine—drills 5 angular oil holes in pan face, sides and front.

Operation 110—Five-Way Machine—drills 8 water holes in banks; rough bores and spotfaces distributor and breather holes; drills oil gallery.

Operation 120—Five-Way Machine—drills and chamfers cylinder head stud holes; semi-finish bores distributor and breather holes; rough bores Nos. 1, 2, 4 and 5 cam bearings.

Operation 130—Five-Way Machine—drills and rough reams valve lifter holes; spotfaces and reams distributor and breather holes; drills 2 oil feeder holes from banks to cam bore; reams oil gallery.

Operation 140—Two-Way Machine—rough bores No. 3 cam bearing; drills and chamfers 22 holes in front end and 5 holes in top.

Operation 150—Five-Way Machine—drills and chamfers 11 holes in underbanks and 12 holes in front end; drills 2 angular oil holes.

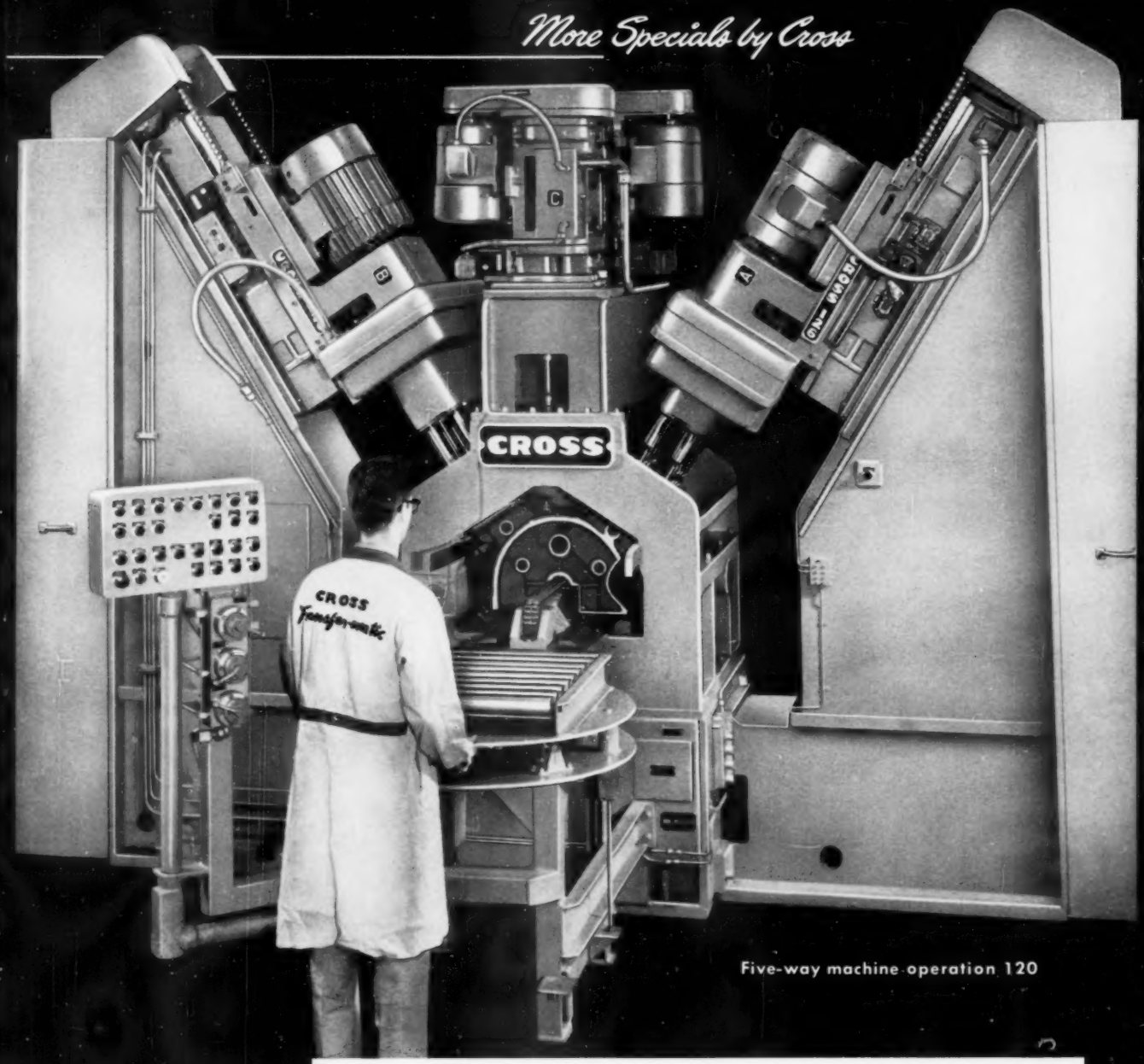
Operation 160—Five-Way Machine—drills and chamfers 6 holes in sides; drills 21 pan holes; drills and counterbores angular hole in rear end; drills 3 oil holes crank to cam.

Operation 170—Four-Way Machine—drills and chamfers 10 holes in sides; drills bearing cap bolt holes; end mills start for angular hole in front.

Operation 180—Three-Way Machine—drills and chamfers 13 holes in rear end; chamfers 20 pan holes; counterbores bearing cap bolt holes; counterbores angular hole in left side.

Floor plan of 16 single station machines for processing cylinder blocks

More Specials by Cross



Five-way machine operation 120

Here is a new kind of manufacturing line—one that utilizes automation for low volume production. It machines truck engine blocks at the rate of 15 per hour.

The unique material handling arrangement for the line permits one operator to take care of several of the 16 machines. To load any machine, the operator merely places the part on the turntable, rotates it 90 degrees, moves it about six inches toward the machine and pushes the cycle button. The machine then takes hold of the part, draws it into the work holding fixture, locates and clamps it, performs the machining operation and ejects it back onto the turntable—all automatically.

Other features include: complete interchangeability of all standard and special parts, construction to JIC Standards, hardened and ground ways, hydraulic feed and rapid traverse, and automatic lubrication.

Established 1898

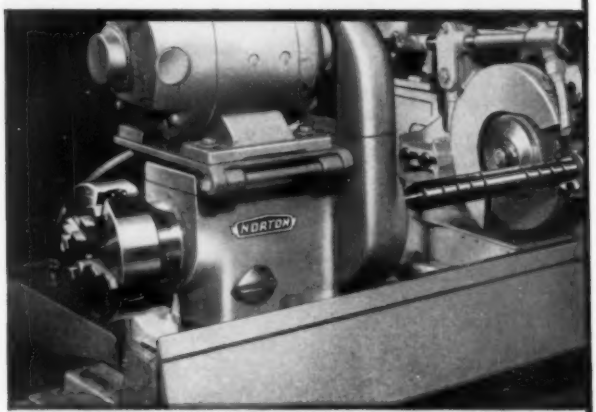
THE **CROSS** CO.

First in Automation

PARK GROVE STATION • DETROIT 5, MICHIGAN

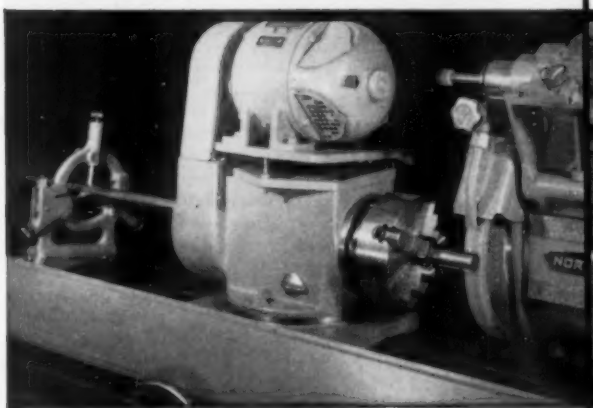
Norton builds extra versatility into universal grinders...

JOB-SPEEDING FEATURES

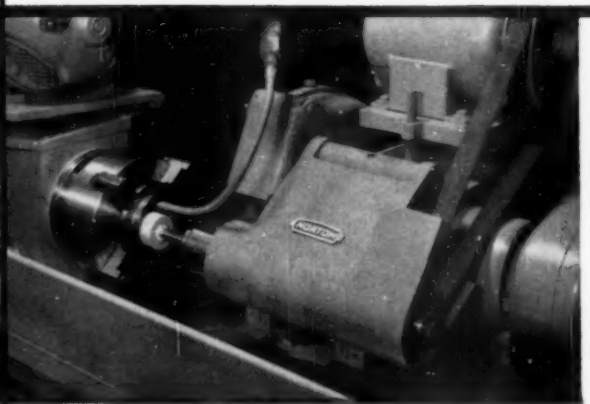


Minimum effort to change from dead center to chucking work. Chuck may remain mounted at back end of headstock while dead-center grinding.

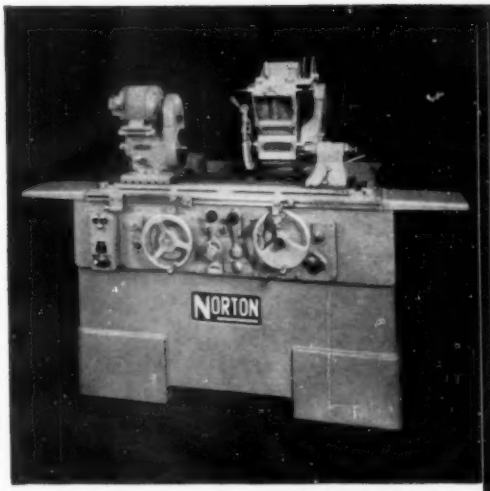
to put extra dollars in your pocket



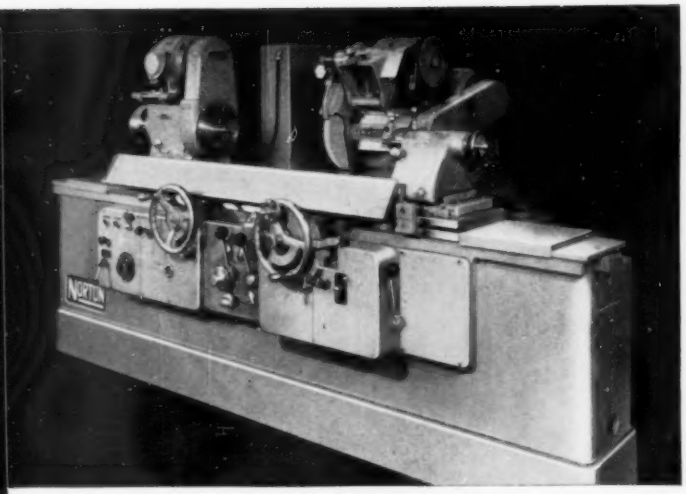
Hollow headstock spindle gives you additional capacity for grinding long bars by passing them clear through and supporting them in grinding position.



Hinged-bracket type internal grinding spindle swings up and out of the way when not in use. This means quicker setups for your I.D. or O.D. grinding.



Norton 10″ universal grinder. Made with 20″ or 24″ nominal lengths between centers. Catalog 170.



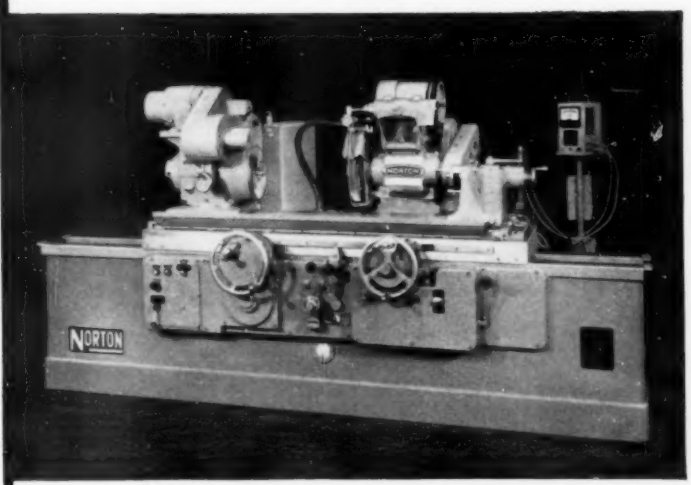
Norton 12″ Type U-4 universal grinder. Made with 36″ or 48″ nominal lengths between centers. Catalog 231.

Many a user rates his Norton universal grinder as a practically "complete grinding department." Why? Because Norton builds extra versatility into its universals for faster external, internal, face, taper and angular wheelside grinding, including many special jobs. Also they're built with many famous job-speeding, cost-cutting features: For example:

Extremely rapid chucking . . . quick change-over to live or dead spindle operation . . . easy work speed changes . . . independent wheel settings that do difficult jobs fast . . . extra capacities on wheel head and headstock . . . precise swivel table alignment with the SWIVALIGN *Dual Electric Indicator, an optional extra.*

Made In The Size You Need

Norton universal grinders are made in 10″, 12″, 14″ and 18″ swing capacities. That means you can get exactly the size to bring you many time-and-money-saving "Touch of Gold" advantages. For complete facts on these high-efficiency machines see your Norton representative or write us direct. And remember: Only Norton offers you such long experience in both grinding machines and grinding wheels to help you produce more at lower cost. NORTON COMPANY, Machine Division, Worcester 6, Massachusetts.



Norton 14″ Type U-4 universal grinder. Made with 36″, 48″ or 72″ nominal lengths between centers and also in 18″ swing capacity. SWIVALIGN* Dual Electric Indicator, at right of picture, measures swivel table adjustments and is optional on all Norton universal grinders. Catalog 819.

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Making better products . . . to make your products better

NORTON PRODUCTS: Abrasives • Grinding Wheels • Grinding Machines • Refractories
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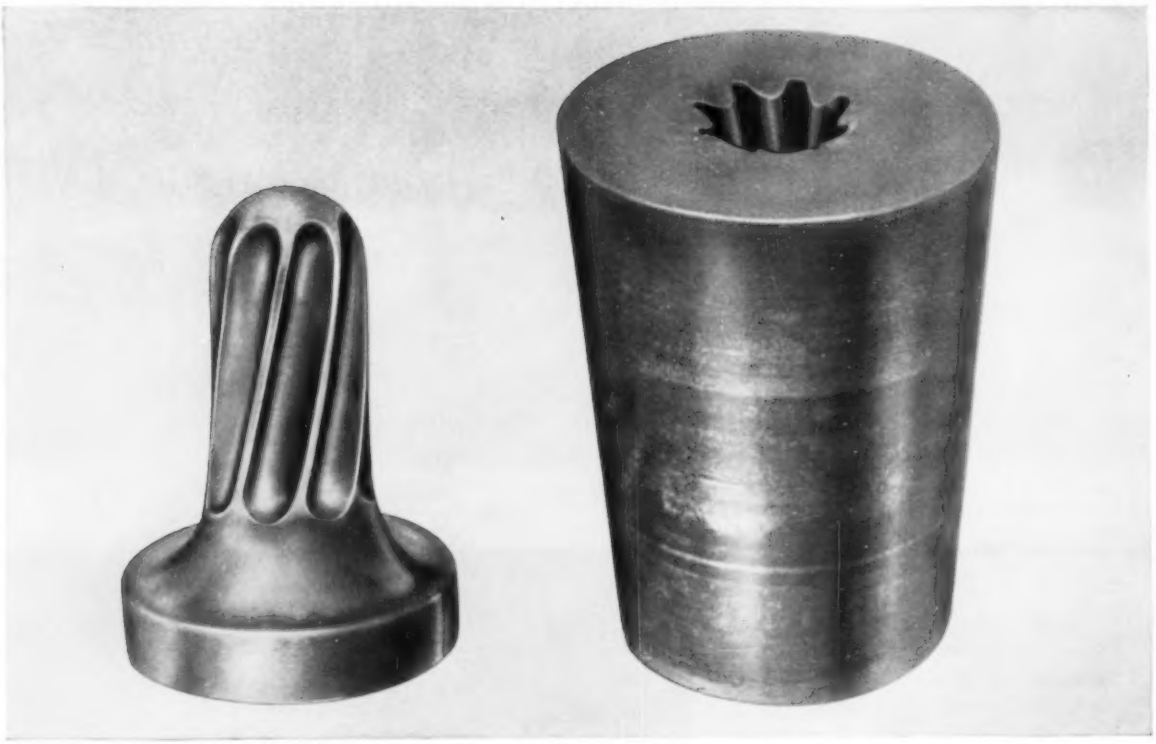
District Offices: Worcester • Hartford • Cleveland • Chicago • Detroit
In Canada: J. H. Ryder Machinery Co., Ltd., Toronto 5

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries



Cold-hobbed die insert of UHB PREMO, with hob of UHB-711

This Large Plastic Mold Was Cold-Hobbed From UHB PREMO Tool Steel

Unusual Operation Shows PREMO's Excellent Cold-Hobbing Properties

Here's an example of tool steel performance that speaks for itself. The die insert shown above was used in a plastic mold for an appliance component. It was cold-hobbed from Uddeholm's UHB PREMO. Before hobbing, the blank measured $7\frac{5}{8}''$ in diameter and $8\frac{7}{8}''$ in height with relief of 5° + 5°. The hobbed cavity measured $2\frac{3}{4}''$ diameter across grooves and 5″ overall hobbing depth, with 81° mean helix angle of splines. The size and shape of the cavity made hobbing questionable. With UHB PREMO, however, there was no difficulty.

A 1,000 ton Sack & Kiesselbach hobbing press was used—with 110 tons pressure per sq. in. on the projected hobbing area. The insert was hobbed in four stages and annealed at 1400°F. between hobbings. PREMO's highly uniform grain structure permitted it to "float" away from the cavity—with no trace of checking or unfavorable distortion. Another dependable performer, Uddeholm's Shock Resisting UHB-711, hardened to Rockwell C-60, was used for the hob.

You can expect results like this from all of Uddeholm's fine, Swedish quality tool steels. For a specific tool steel need, analysis alone won't always tell the whole story. *Performance* is the final measure—and in performance Uddeholm tool steels have often *succeeded* where others of similar analysis have failed.

Write For
Tool Steel Stock List No. 12

UHB

UDDEHOLM COMPANY OF AMERICA, INC.

Tool and Die Steels
Cold Rolled Spring Steels

Offices and Warehouses

New York: 155 East 44th Street, MUrray Hill 7-4575
Cleveland: 4540 East 71st Street, DIamond 1-1110
Los Angeles: 5037 Telegraph Road, ANgelus 2-5121

District Representatives

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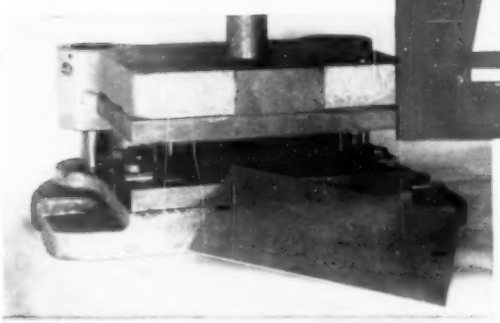
DETROIT: Wafren H. Nugent, 17304 Lahser Road, KEnwood 5-6340
PHILADELPHIA: Frank T. Campagna, 1418 Walnut St., PEnnypacker 5-2114
PITTSBURGH: Lohmeyer Steel Co., 345 Mount Lebanon Blvd., LOcust 3-0122

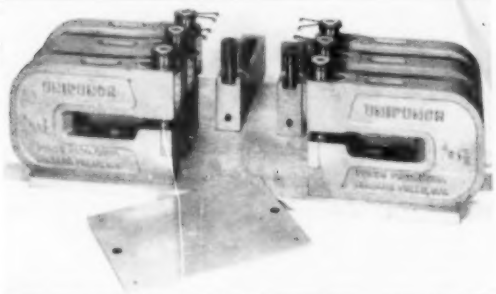
UNIPUNCH®

TOOLING IS MORE THAN A PRODUCT LINE . . .

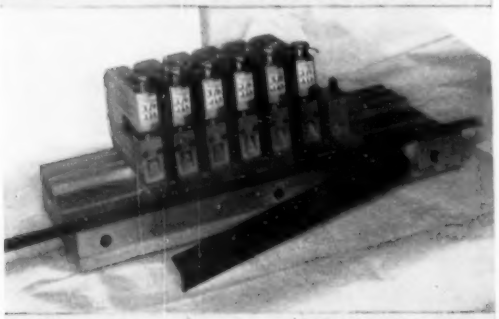
. . . IT IS A COST SAVING METHOD!



1 For cost comparison, the above custom made, single-purpose conventional die to punch 6 holes cost **approximately $325.00.**



2 Unipunch template set up of 6 units to punch the same six holes as the conventional die above, costs **only $271.36.**



3 Same 6 Unipunch Units as shown in photo No. 2 for punching 6 different diameter holes in angle requires only 6 punch bodies and 6 die buttons reducing cost of tooling second part to **only $23.70.** If same diameter holes were in this angle as in No. 2 work piece there would be **no additional cost.**

The UNIPUNCH METHOD uses a wide range of standard interchangable units and parts to lower production costs. This method permits any number of units to be set up quickly outside the press, placed on press bed and produce finished parts with first stroke of press ram. Nothing is attached to press ram . . . down-time cut to minutes.

The same group of units may be set up in unlimited patterns keeping the tooling investment in continuous operation for greater savings. An example of these savings by the UNIPUNCH Method is shown at left. It's a great big economy story.

Always UNIPUNCH® specify

Write Today ▶ for FREE Methods Book

PUNCH PRODUCTS *Corporation*

3810 HIGHLAND AVENUE, NIAGARA FALLS, NEW YORK

Production time reduced 82% on new lathe

PROFIT POINT — TURNING

New Barber-Colman 36-speed lathe does 13 operations on drive gear and shaft in 22.7 minutes

Turning time on the drive gear and shaft shown in the illustration was reduced from 126 minutes to 22.7 minutes when transferred from an old lathe to a new Barber-Colman 36-speed lathe.

The shaft is 15″ in length with a maximum diameter of 3.744″. Spindle speeds range from 644 rpm to 912 rpm, and the feed is .013″ per revolution. On the old lathe, speed was 350 rpm and the feed was .015″ per revolution. This is a good example of how machine horsepower, accuracy, rigidity, and operational features can reduce costs drastically.

Easy-to-set up Barber-Colman lathes combine power and precision for profitable optimum speed turning with negative-rake throwaway insert tools. They're heavier and wider through the carriage than most lathes of their size. Controls are "human engineered" to make a busy operator's job easier and more efficient. Yet they offer every toolroom feature you can name, plus guaranteed accuracy for precision work.

STANDARD TIME	OLD LATHE	NEW 36-SPEED LATHE
SETUP TIME (hours)	1.09	1.75
SPEEDS (rpm) FEED (inches per rev.)	350 .015	644 to 912 .013
PRODUCTION (per hour)	0.47	2.64

Opportunities in cost-cutting modernization

There'll never be a better time to buy a new lathe, or greater opportunities to reduce costs through equipment modernization. Here are two good reasons:

1. *Throwaway insert tools* are the biggest "break-through" in lathe "economics" in 30 years. Think of what it costs you to sharpen, change, and reset conventional tooling! Throwaway inserts make your perishable tool costs so low in relation to part costs and the cost of operating a machine, the only sensible thing to do is boost speeds, burn up tools faster, and reduce floor-to-floor time.

2. *It's the right time to buy machine tools*, because you can "pick and choose" — get the right machine and tooling for your assortment of jobs. The increase in productivity will prepare your plant for periods of high volume, spiraling costs, and labor shortages tomorrow.

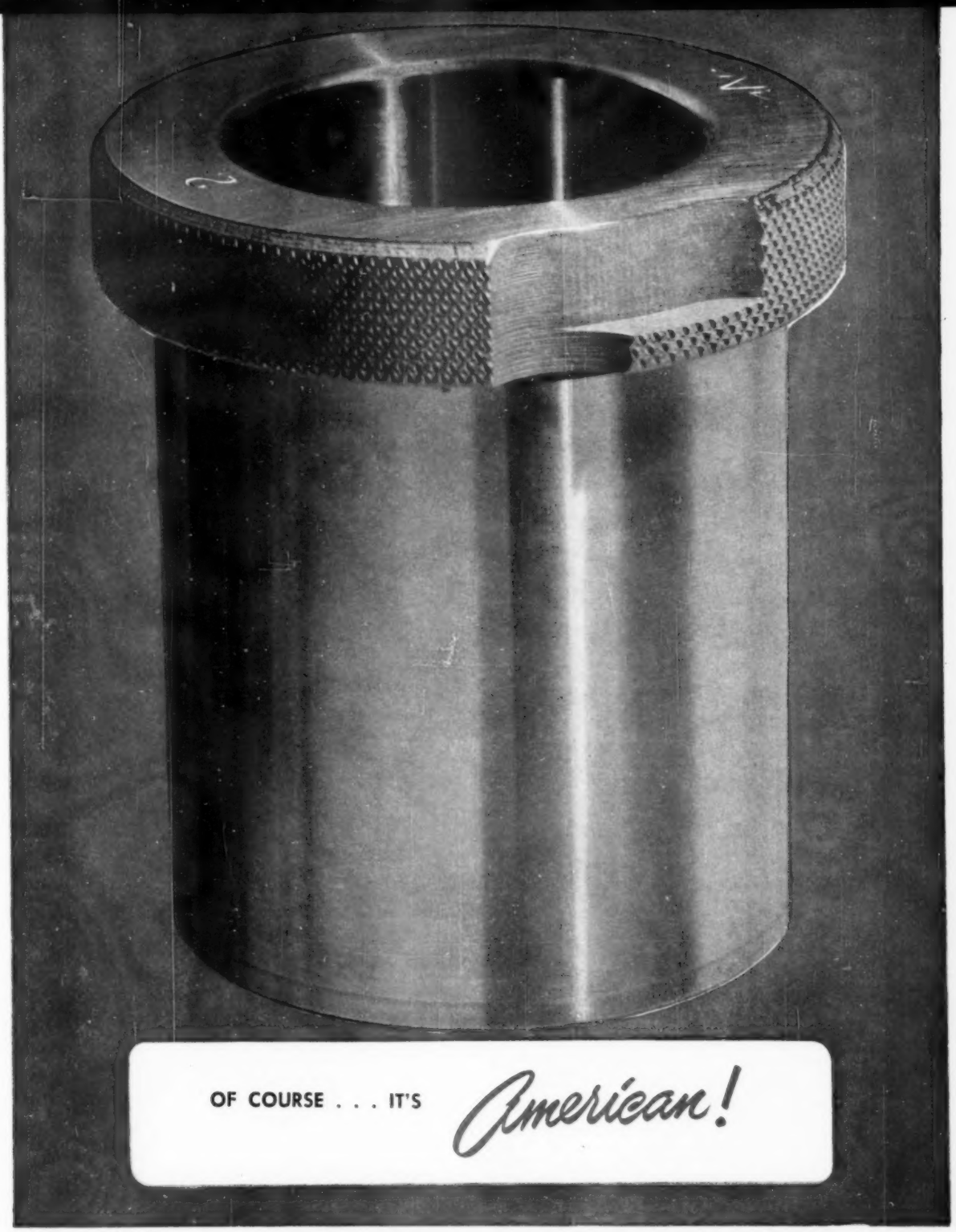
Now in production in two sizes, these new machines will pull 25 hp through the spindle and operate at speeds up to 2000 rpm.

Barber-Colman Company
123 Loomis Street, Rockford, Illinois

Don't expect a day's work for a day's pay on yesterday's machine tools.

BARBER COLMAN®

PRECISION LATHES



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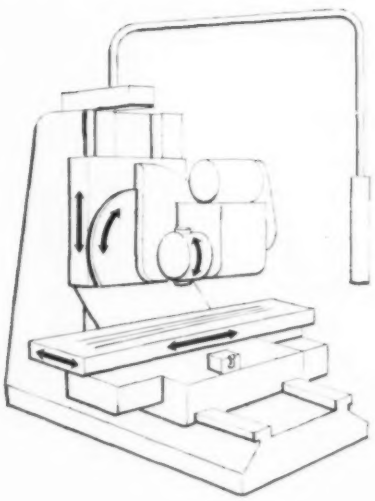
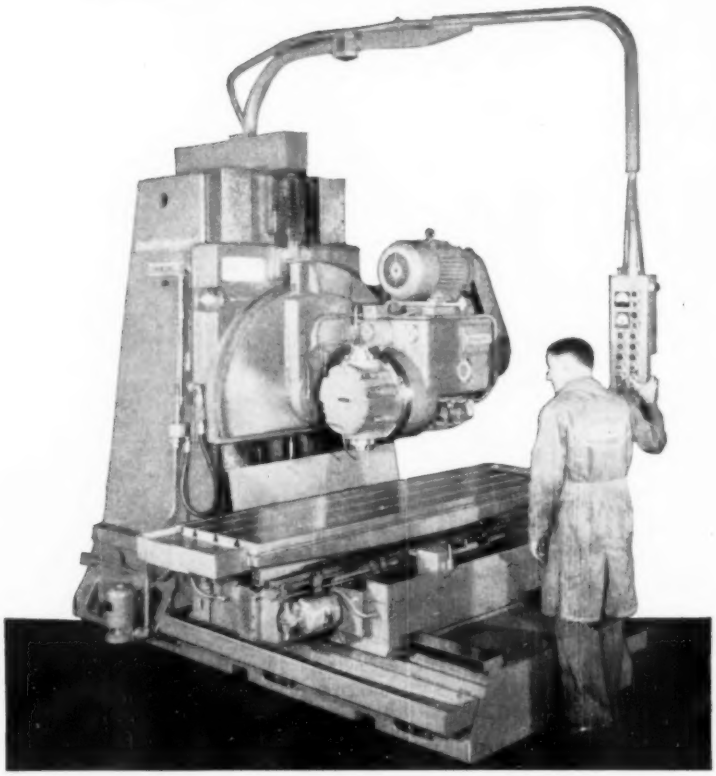
NEW SUNDSTRAND OMNIMIL

...machines at any and all angles!



New Omnimil is a precision five axis machine tool with possible directions of movement and adjustment indicated by arrowheads on sketch above.



This new Sundstrand machine combines the rigidity of a heavy duty milling machine, the versatility of an all-angle head and the range of a boring mill. That's outstanding flexibility and work capacity in a single machine. It can handle milling, boring and drilling operations on ferrous and non-ferrous parts in an almost unlimited range with outstanding precision and minimum work handling because spindles are adjustable to any angle. A 15 hp double spindle head offers both a low speed range from 25 to 400 rpm at one spindle and a high speed range of 250 to 4000 rpm at the second spindle. Both spindles have quick speed change.

Power feed rates are infinitely variable between ½ and 200 inches per minute for longitudinal and transverse feed and ¼ to 100 inches per minute for vertical feed. Pendant control in increments of less than .001 inch is provided for setup. No other machine offers anywhere near the flexibility and production capacity available in the Omnimil. With the Omnimil fewer set-ups are required and consequently less expensive fixturing. Positive clamping of machine members without distortion of location is the Omnimil feature that permits outstanding accuracy in performance.

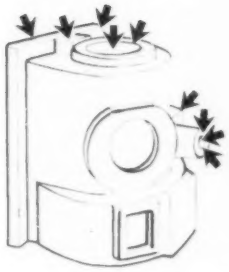
SUNDSTRAND "Engineered Production" Service"

AUTOMATIC LATHES | SIMPLEX RIGIDMILS | DUPLEX RIGIDMILS | TRIPLEX RIGIDMILS | SPECIAL MACHINES

See for yourself . . .
how the Omnimil's versatility pays off in performance . . .

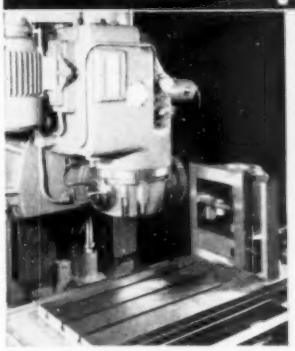
Six of the 15 operations on a housing part are shown below. All 15 operations are done in two set-ups . . . only *one* relocation of the part.

Because all the work can be handled on one machine, the capital investment and the number of skilled operators required are held to a minimum. Instead of several machines lightly loaded, one machine is kept working near its rated capacity.



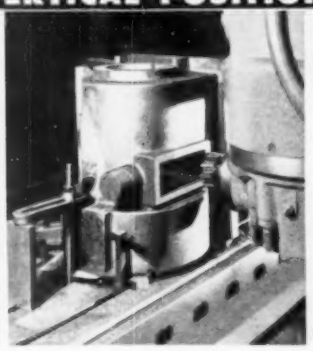
Arrowheads indicate surfaces machined with part vertical.

VERTICAL POSITION



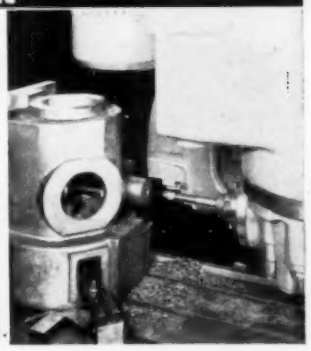
Operation No. 1 —

Profile milling bottom of housing also provides locating surface for part during second set-up. Head in position No. 1.



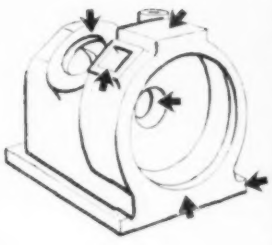
Operation No. 5 —

Profile milling cover pad. Note that smaller tungsten carbide cutter is used and head is now in position No. 3.



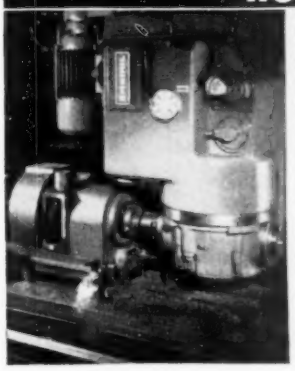
Operation No. 8 —

Finish bore 1" diameter hole in boss. Boring operations are performed on the Omnimil with outstanding precision.



Arrowheads indicate surfaces machined with part horizontal.

HORIZONTAL POSITION

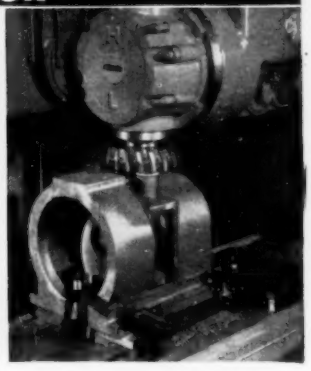


Operation No. 11 —

Rough bore 5" diameter in end of housing using tungsten carbide boring head with Omnimil head in position No. 5.

Operation No. 14 —

Milling second of two angular pads with 9" diameter cutter. Precise angle needed is set quickly and accurately. Head is in position No. 6.



Operation No. 15 —

Final operation consists of milling the pad on top of housing with same milling cutter as in previous operation but with head in position No. 2.

Both a larger version of the 15 hp Omnimil and a 50 hp vertical Rigidmil with three directional feed are among the newest ideas in universal machines available from Sundstrand. All three machines are described in Bulletin 798. Write for your copy today.

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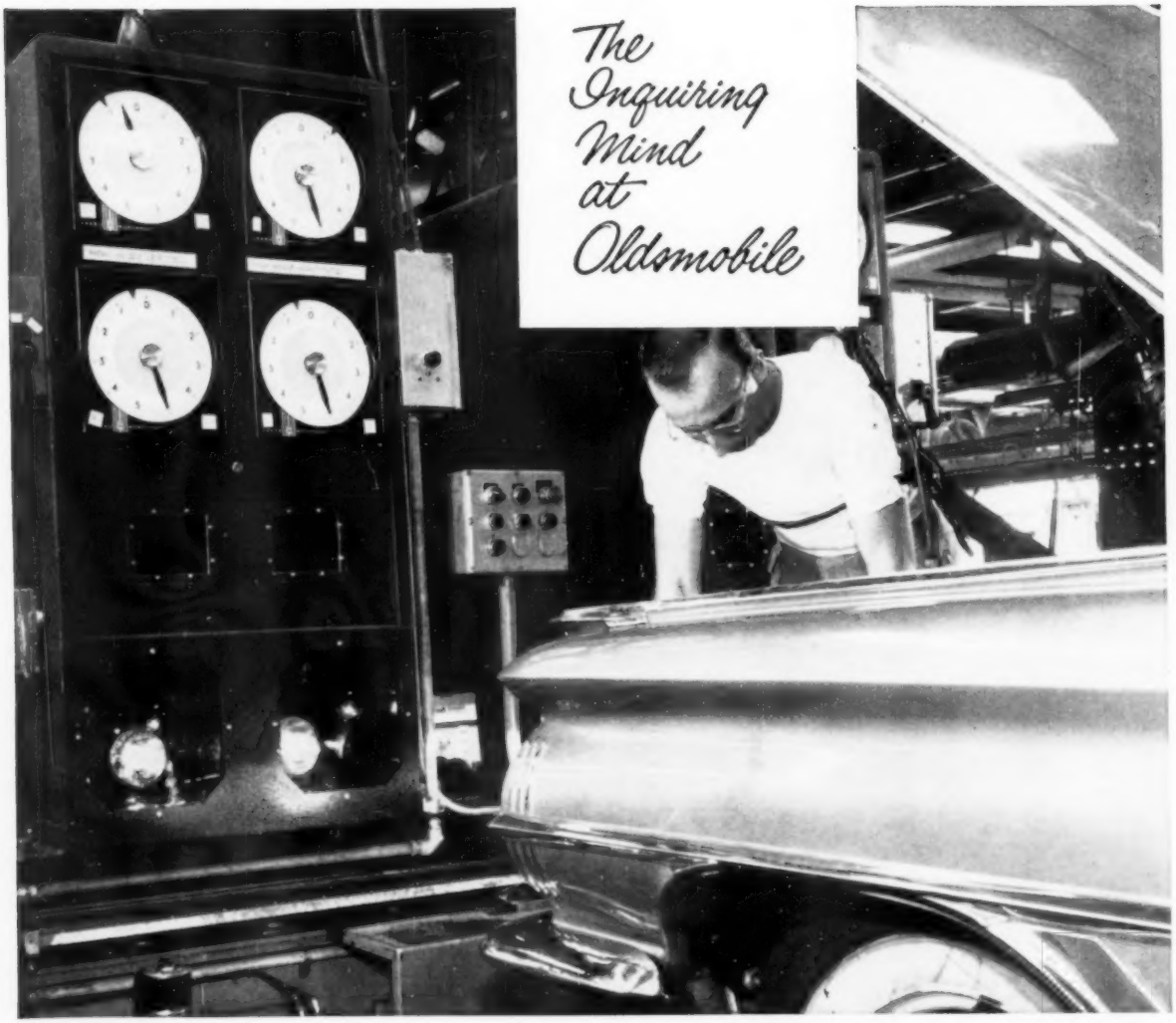

no. 5 OF A SERIES

LIGHTING YOUR WAY TO A SAFER FUTURE

Safeguarding lives is the aim of Oldsmobile's new electronic headlamp aiming device that makes sure every Oldsmobile has perfect "see-ability".

Night driving safety depends upon how precisely headlamps are aimed. Minute errors in adjustment can mean the difference of several square feet in light area on the road. To be completely on the "safe side", Oldsmobile aiming standards specify that lights be aimed *twice* as accurately as required by state laws.

To make certain that every light is aimed perfectly, Oldsmobile engineers developed an ingenious electronic device that effectively measures light intensity and direction, even at Oldsmobile's highest production rate.

On the assembly line, every car is automatically shuttled to the aiming platform where two probes rise out of the floor and "feel" the exact location of the car. The "eyes" of the aiming device then align themselves with the centerline of the car. A series of photoelectric cells instantly record the light intensity and direction on large dials. A built-in scanning circuit then inspects all settings of the headlamps to make certain they are accurate. If there is an error, a colored soap solution is automatically sprayed on the windshield, and the headlamps are re-aimed.

Oldsmobile takes pride in producing an automobile as advanced in every respect as modern technology can make it. However, you owe it to yourself to have your headlamps periodically checked. As part of General Motors' public-spirited "Aim to Live" program, your Oldsmobile Dealer is featuring headlamp aiming, as well as other important safety services for you. Stop in soon . . . and while you are there, take a test drive in a new Olds—sales leader of the medium price class.

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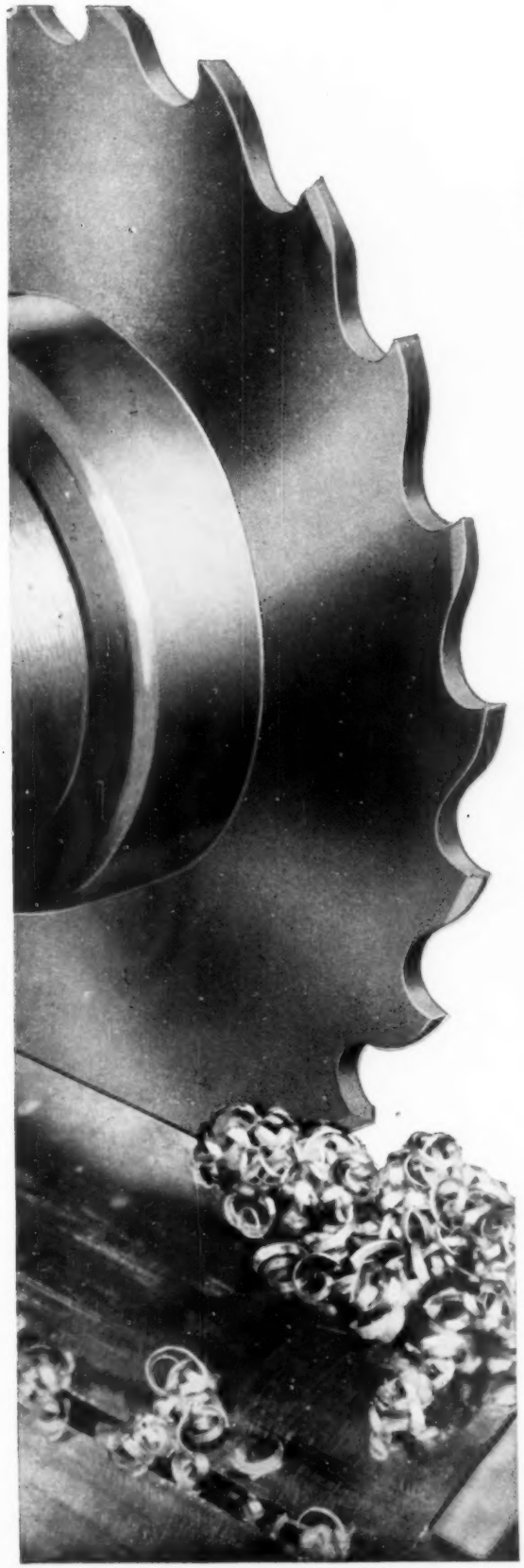
OLDSMOBILE

Pioneer in Progressive Engineering ...Famous for Quality Manufacturing



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Q *Quality*
S *Service*
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MOTCH AND MERRYWEATHER

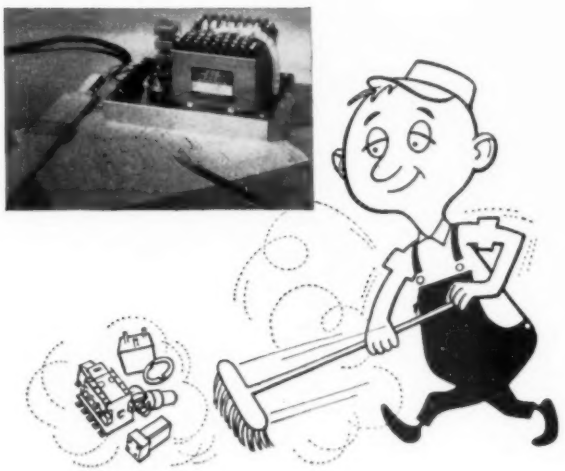
Cutting Tool Manufacturing Division
Cleveland 17, Ohio

JOURNAL OF APPLIED CONTROL DEVICES THAT NEVER WEAR OUT

For Control Engineers Who Are Wearing Out Before Their Time

HIGH SPEED STATIC SWITCHING *(at half the price)!*

Sylvania Electric Products Co. engineers have just replaced an electronic relay, two small mechanical relays, a limit switch, and a separate power supply with a single CONTROL switching reactor which costs only half as much! They did it by taking advantage of the multiple windings on a CONTROL switching reactor—equipment which, because of its static operation, never wears out. Seems a high speed assembly operation on one of Sylvania's complex, highly automated vacuum tube production machines calls for a magnetic clutch to drive an index table. The clutch orients the work part by rotating it until current flows through two properly located contacts. Our CONTROL switching reactors not only cut costs in half, but do a job that the relays couldn't do: provide the ultra high speed signal necessary for proper switching in the automated assembly. *It worked so well Sylvania said, "I'll be switched!" We said, "With a 10,000 to one switching ratio, and ratings of 15, 75, 150 and 300 VA, most anything for control can be!"*

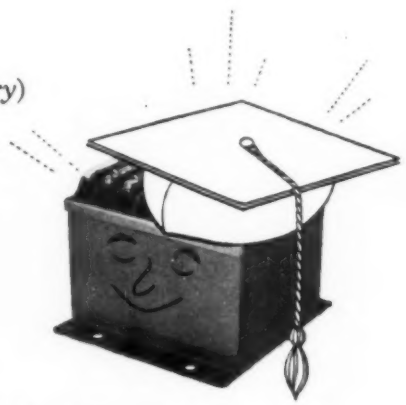


ONCE UPON A TIME . . . *(time delay, that is)*

Versatile, we are too! The same type of CONTROL switching reactors that work so well for this high speed switching also are used by Sylvania engineers to eliminate production breakdowns caused by relay failures in time delay circuits. Many pneumatic time delay relays on their production machines were dying young (three months of age or less). CONTROL switching reactors (which, naturally, never wear out) not only have no moving parts, but do a dandy job with time delay relaying, easily handling 6,000 closures per hour. Sylvania happily expects its CONTROL reactors to last twenty years. *"Right now," Sylvania says, "we're not too worried about what will happen after that." Need you be any more worried than they?*

LOGIC, MY DEAR WATSON *(. . . is elementary)*

Our educated switching reactors are masters at logic—the kind that gets built into automatic control operations. AND, OR, NOT, MEMORY and TIME DELAY—all are built into these high IQ reactors. By employing several isolated control windings, one reactor can translate many inputs (from push buttons, limit switches or other reactors, for instance) to any logic needed to switch very appreciable loads. And are they easy to use! Order standard units right from the catalog. You need no high falutin' systems engineering or auxiliary hardware (single purpose logic units, preamplifiers or transformers). *No wonder logical people order our logic-providing switching reactors. Can we send complete details to you?*



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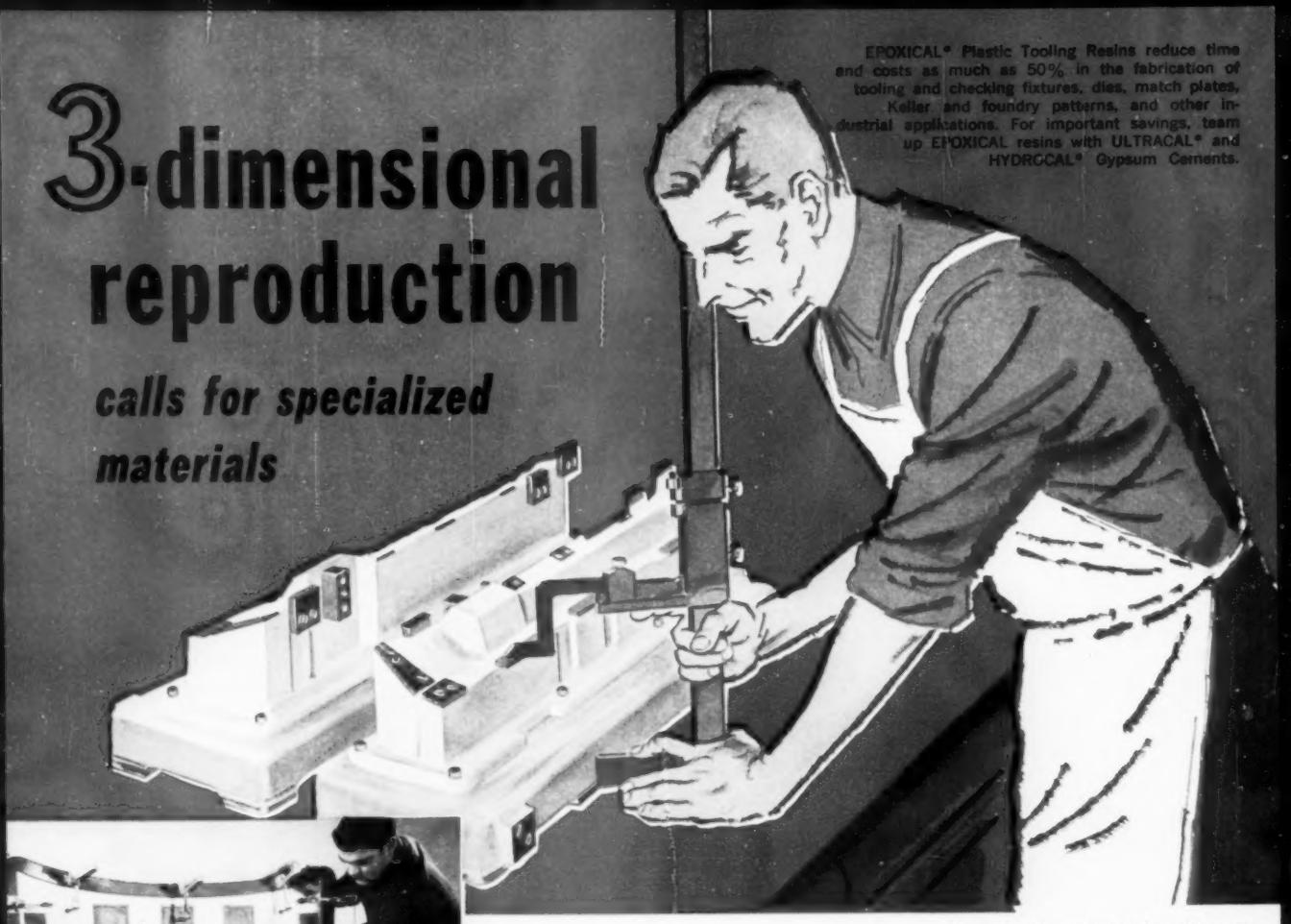

Courtesy High Strength Plastics Corp., Chicago, Ill.

This large check fixture or inspection gauge for an automobile hood panel was laminated with U.S.G.'s exclusive heavyweight .055" Glass Cloth and EPOXICAL® Tooling Resin. High bonding strength and excellent wetting characteristics are just two of the many reasons why industrial tooling and patternmaking firms are changing to EPOXICAL Tooling Resin and accessories.

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Talking About Die Sets

with

Phil Marsilius

Executive Vice-President
The Producto Machine Co.

Die Set Maintenance in the Pressroom—The vital die-maintenance procedures required periodically when a die is removed from the press for sharpening should be coupled with systematic die set inspection and maintenance in the pressroom.

In addition to having a planned schedule of lubrication (based on any of the methods previously discussed in this space), you can make sure of getting the most out of your investment in die sets—and the costly dies and presses with which they are used—by following a simple set of procedures for inspecting and maintaining die sets in the pressroom.

Although there are no hard-and-fast rules that can be established for all die sets, the procedure listed below is generally followed at leading stampings plants in the East. These companies point out that die sets used in the cutting of extremely thin material or for very critical parts would naturally require a more stringent inspection than those used for blanking heavy material or for comparatively simple parts.

At one plant, specializing in long runs of close-tolerance parts for the electronics industry, the procedure followed is:

1. No inspection of the die set during production run unless, of course, there is overheating, pick-up on the guide pins or other obvious difficulties.

2. When the die is taken off the press for sharpening or maintenance, the die set is visually inspected for pick-up or score marks on either the guide pins or bushings. Pins and bushings are carefully cleaned to remove excess lubricant.

3. After approximately 1,500,000 strokes, the set is thoroughly checked for wear on both the pins and bushings. On the average, up to .0003″ wear on pins and bushings is allowed before replacement with new components is scheduled. In addition, the die set is placed on a surface plate and an indicator is placed over one end of the set. An attempt is then made to rock or twist the set by hand to establish how much the die set can be deflected. On a 10″ set, a maximum of .005″, but usually less, total deflection is allowed.

Because the die set plays such an important part in prolonging the accuracy and lifetime of a die, it pays to take the little extra time required to do justice to die set maintenance in the pressroom.

4. During regular or periodic regrinds, the die set is not checked for bent or distorted punch and die holders unless the die has been damaged or there is reason to believe the set may have warped.

During the overall period, if the pins and bushings are replaced, the punch and die holders themselves are checked for warpage or distortion. If necessary, these components are reground prior to assembling the new pins and bushings.

Four-stage blanking and shaving die, Lenkeit Machine & Tool Co., Inc.

Why the pressroom foreman prefers Producto die sets

They keep his downtime down

Keeping production *up* and downtime *down* is the main job of the pressroom foreman. He knows Producto die sets can help him do this job successfully because they maintain accuracy for long runs. All catalog steel sets are annealed to prevent distortion.

He is aware that Producto can provide him with any type of die set he needs—whether for standard or special presses—in a wide range of sizes and thicknesses, with or without clamping flanges.

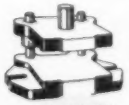
The pressroom foreman knows that Producto guide pins are mirror-finished to eliminate scoring, and that Producto die sets are available with a variety of lubrication devices to keep them "running cool".

He knows, too, that he is not restricted to the use of predetermined press stroke or shut height because Producto offers an unlimited choice of pin and bushing lengths. Moreover, he can get the bolster he needs to protect his die at the same time he gets his die set. Both die set and bolster can be ordered in steel or cast semi-steel depending on strength requirements.

The pressroom foreman realizes that Producto Qwik-Fit Die Sets make "take-apart-and-put-together" easy during die maintenance. He also knows that Qwik-Fit removable pins and clamp-type bronze bushings are available when the application calls for them.

He can *produce more* with Producto die sets. So can you.

A WEALTH OF DIE SET KNOWLEDGE is packed into Producto's Catalog No. 11 and regular issues of *Die Set Digest*. Write today for these free aids.



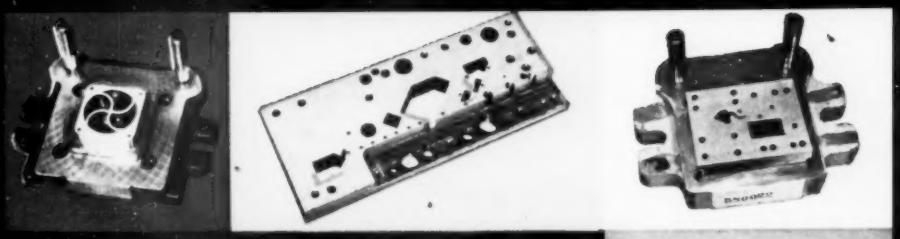
THE PRODUCTO MACHINE COMPANY
930 Housatonic Avenue, Bridgeport 1, Connecticut

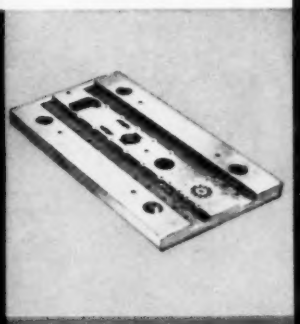
PRODUCTO

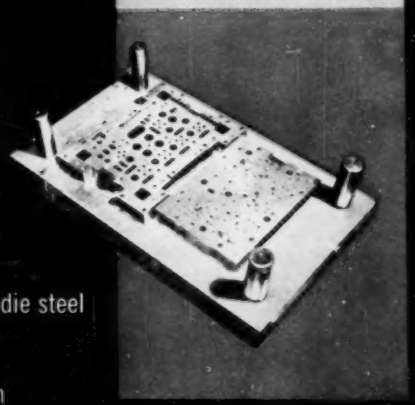
Wherever die sets are used

PRODUCTO

PRODUCE MORE WITH PRODUCTO PRECISION DIE SETS







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air-hardening tool and die steel

is widely recognized as a leader in freedom from size change and distortion. No other steel has such a job-proved record of succeeding where other grades have failed. VEGA was specially developed by Carpenter to combine toughness and the machining properties of an oil-hardening steel with the safety in hardening of an air-hardening grade. We'll gladly prove the facts. Call your local Carpenter SERVICE-CENTER. Complete stocks assure you immediate delivery

the *Carpenter* Steel Company, Reading, Pa.

RICHARD F. MOORE, President
Moore Special Tool Co., Inc.

a man who came to Fair Street

"Like everyone else we had to see the Jigmil Technique before we could believe it"

"Our visit to Fair Street resulted in the purchase of three JIGMILS. The machines are part of a complete retooling program to help us meet rising costs and hold the line on our prices. We use the JIGMILS to machine larger jig borer and jig grinder parts to the fine accuracies required in our own machine tool products. We do not believe that we could design and build a special machine for our own needs that would beat the JIGMIL. For us, the JIGMIL is the last word."

RICHARD F. MOORE

DE VLIEG MACHINE COMPANY, FAIR STREET • **ROYAL OAK, MICHIGAN**

SOME OF OUR JIGMIL USERS

American Steel Foundries
Avey Drilling Machine Co.
Axelson Manufacturing Co.
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Boyar-Schultz Corp.
Brown & Sharpe Mfg. Co.
Bryant Chucking Grinder Co.
Buhr Machine Tool Co.
Cincinnati Milling Machine Co.
Cincinnati Shaper Co.
Cleveland Automatic Machine Co.
Cone Automatic Machine Co., Inc.
Crankshaft Machine Co.
Cross Company
Davis & Thompson Co.
Detroit Broach Company
Ex-Cell-O Corporation
Foote-Burt Company
Gisholt Machine Co.
George Gorton Machine Co.
Gould & Eberhardt, Inc.
Greenlee Bros. & Co.
Heald Machine Company

ADVANTAGES OF THE JIGMIL TECHNIQUE reported by Moore Special Tool Co., Inc.

- Fast, fool-proof positioning
- Quick tool changes
- Fast indexing of part to four sides
- Retraction of table for measuring
- Depth of hole stops
- Quick change of wide spindle speed range
- Large range of boring bars from DeVlieg stock
- Easy accessibility to controls

ACCURACY IS AN ECONOMY!

JIGMIL—THE MACHINE TOOL BUILDERS' MACHINE TOOL

Moore uses its three JIGMILS with DeVlieg Microbore boring bars to mill, bore, drill and tap large components for its own line of ultra precision machine tools. A jig grinder spindle housing is shown being machined on their 2B-36 JIGMIL equipped with a DeVlieg 20" x 20" index table. Parts are rough and finish machined to precise limits of accuracy on four sides in one setting by simply indexing the index table.

Ingersoll Milling Machine Co.
Jones & Lamson Machine Co.
Kearney & Trecker Corp.
Landis Tool Co.
R. K. LeBlond Machine Tool Co.
Lees-Bradner Company
Lodge & Shipley Company
Mechanical Specialties Co.
Moore Special Tool Co., Inc.
National Automatic Tool Co., Inc.
National Machinery Co.
Onsrud Machine Works
Rockford Machine Tool Co.
Snyder Tool and Engineering Co.
Sundstrand Machine Tool Co.
Warner & Swasey Company

WILL YOU BE THE NEXT TO VISIT FAIR STREET

Our newest catalog will help you decide. May we send it?

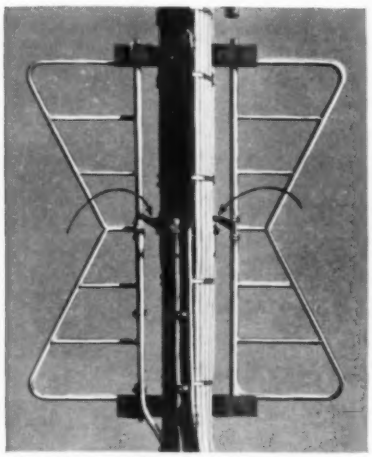
DeVlieg

SPIRAMATIC JIGMILS®

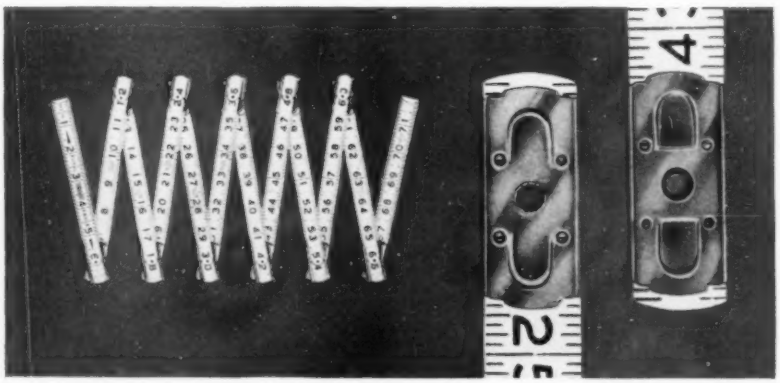
ACCURATE HOLES AND FLAT SURFACES IN PRECISE LOCATIONS

TRY A FRESH APPROACH

Don't just take your metals for granted—specify the properties you need. The Man from Anaconda may come up with some very interesting answers.



Up where TV broadcast antennas stand, normal wind causes flexing of metals. So jumpers between coaxial cables and radiators must be resilient – beside being conductors, giving some structural support. Ordinary phosphor bronze seemed adequate, but there were fatigue failures.

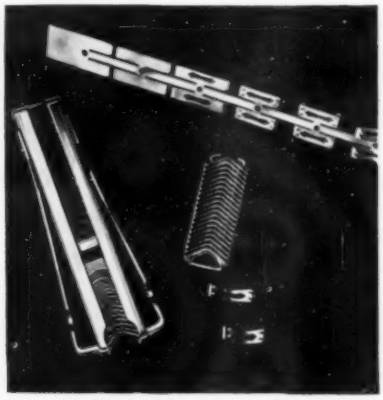


To stimulate sales of its top-quality folding rule, and to meet Navy specifications, Eagle Rule Mfg. Corporation sought a metal for rule joints that would resist wear and corrosion, and provide the proper spring tension. Phosphor bronze, which had these qualities in excess of needs, cost too much.

American Brass suggested three alloys. Eagle Rule chose Ambronze-420 (88 Cu, 11 Zn, 1 Sn) because rule joints of this alloy met all requirements, withstood 400,000 cycles in wear test (Navy required 7000). It cost only pennies per pound more than yellow brass, much less than phosphor bronze.

RCA listed desirable properties of phosphor bronze – added *extra*-high endurance, *extra*-long fatigue life. American Brass suggested Duraflex®, Anaconda superfine-grain phosphor bronze. RCA tried it, found it the answer–at no extra cost–specified Duraflex to the manufacturer, Dielectric Products Engineering Co., Inc., Raymond, Maine.

Technical Oil Tool Corp. asked Anaconda to help select the metal for a new magazine-type clip used to close surgical incisions. The metal had to provide the right tension to hold edges together, yet open easily–form readily, hold sharp die-cut edges, be proved in surgical use.



American Brass technical specialists suggested Nickel Silver, 18%-719 as best suited to meet all requirements. Autoclip, shown in use above, is the result. Incisions are held together with least damage to tissues. Surgeons can work faster in applying and removing clips.

STARTING with 93 standard alloys, The American Brass Company can make minor variations in composition, fabrication, and annealing to provide an almost unlimited number of combinations of useful properties. When new or unusual problems arise, ask for the help of the Technical Dept. in selecting the right metal. For such help or a copy of Publication B-32, "Anaconda Copper & Copper Alloys," write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario, Canada.

6809

ANACONDA®

COPPER • BRASS • BRONZE • NICKEL SILVER
MILL PRODUCTS
Made by The American Brass Company

PRODUCTION POINTERS from GISHOLT

More cost-cutting IDEAS– to help you

CHAPMAN VALVE SAVES 155 MINUTES ON CHECK VALVES

Improves quality...cuts costs and maintenance of form tools

Here's a way to save time and money by applying new thinking to old jobs. With this setup on a new Gisholt MASTERLINE 2L Saddle Type Turret Lathe, The Chapman Valve Manufacturing Co., Indian Orchard, Mass., saves an average of 155 minutes on each of 4 sizes of cast carbon steel tilting disc check valve bodies.

Special equipment includes a reduced feed selective gear box, a "tenth" dial indicator and longitudinal feed dial for the cross-feeding hex turret plus a fixed, 25°-angle cam in the cross-feeding turret taper attachment.

Here's the sequence on a typical 6" valve body:

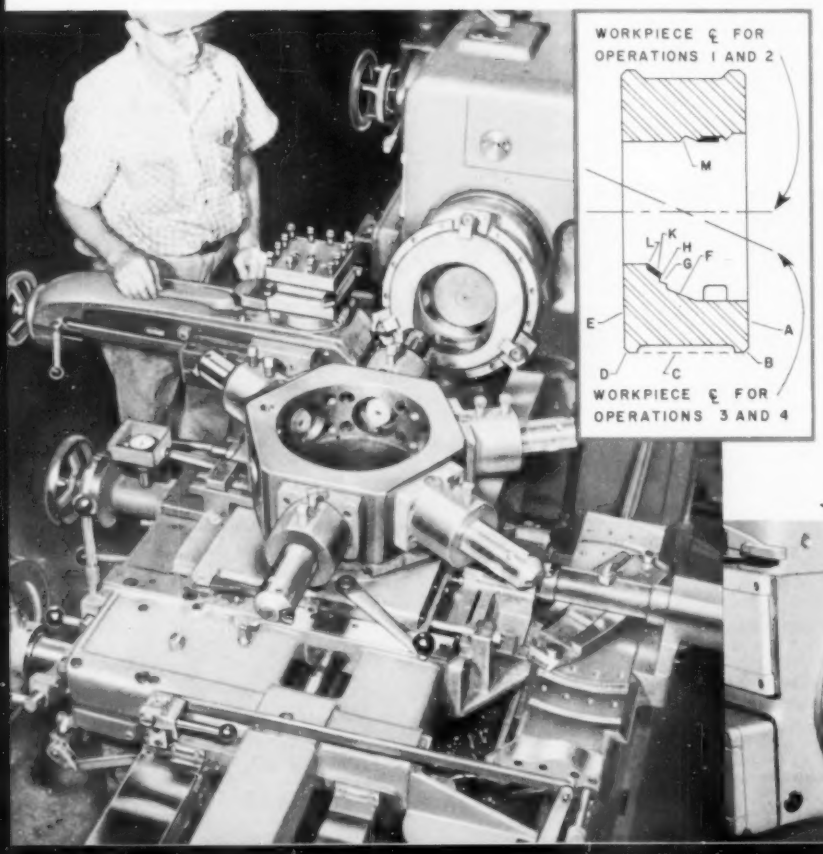
Operation 1—Chuck at C, locate at E in 18", three-jaw air chuck. Face A, chamfer B and turn C to chuck jaws. Time, 43.0 min. f.t.f.

Operation 2—Using same chuck, locate at A, hold at C. Face E, chamfer D and finish-turn C. Time, 31.0 min. f.t.f.

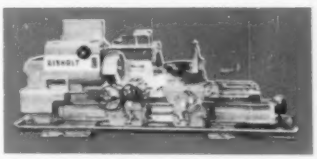
(In these two roughing operations, ½" stock is removed on diameter and ⅝" per side on facing. Hex and square turrets are used simultaneously wherever possible to save time.)

Operation 3—The part is placed in a counterbalanced, angle fixture. It is oriented to a scribed mark on the fixture, located against surfaces C-E and hand-clamped at A. The longitudinal feed dial and "tenth" indicator are used to speed positioning as hex turret tools rough- and finish-bore surfaces F-G-K-L-M. The 25° fixed cam in the taper attachment assures accuracy and rigidity on surfaces K-L. Time, 24.2 minutes, f.t.f.

Operation 4—The stainless steel valve seats are inserted in a separate operation. Then back to the 2L, where the same fixture and holding method as in Oper. 3 is used for finishing the seats. Only hex turret tools are used as surfaces F-G-M are remachined to remove welding flash. The stainless steel valve seat is faced at H and taper-bored at K, using the dial indicator to hold the close tolerance in the bore. Time, 34.8 min. f.t.f.

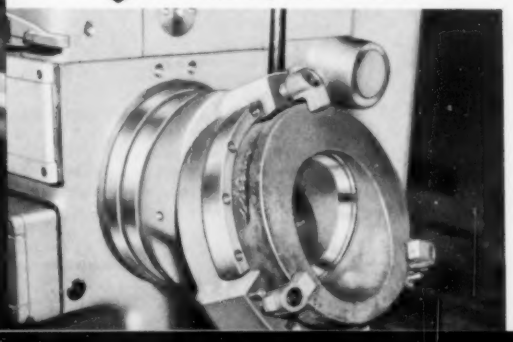


One new machine saves 155 minutes machining time per part, replaces two older units. New tooling method eliminates cost and maintenance of form tools. Reduced feed gear box for seat boring provides 32 micro-inch finish. Additional savings are derived through reduction in lapping time.



Tooling for Operation 4. Note dial indicator at left and 25°-fixed-angle cam in taper attachment at right. Low-cost standard carbide tools on cross-feeding hex turret replace expensive form tools previously used.

Close-up of workpiece after Operation 4 and fixture. Drawing shows surfaces machined.



STANDARD MACHINE INCREASES PRODUCTION 250%

Avoids cost of special machine with smart chucking, compact tooling

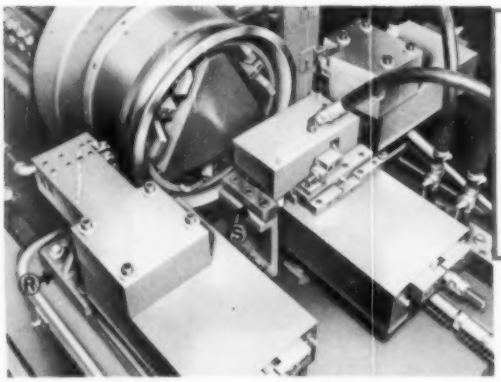
Here several tooling tricks are revealed in the way 20½"-diameter, 2"-wide steel brake ring forgings are machined. Two Gisholt Simplimatic Automatic Lathes replace older machines, increasing production from four to ten parts per hour.

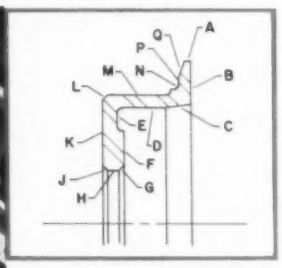
For operations 1 and 3 on the first machine, distortion of forgings is avoided by locating against K in a drawback fixture, centralizing on three pins in bore H. Three clamps, with two swivel fingers on each, hold at six points on web F. Front slide tools rough-turn M-A with extra support from bracket R. Center slide tools rough-bore D, undercut E, and rear slide tools straddle-face P-B. Total time, 3.6 minutes f.t.f.

A similar fixture is used for operations 2 and 4 on the second machine. Work locates against B, centralizes on a chucking ring at D, and clamps at P. In operation 2, front slide tools rough-bore H, and rear slide tools straddle-face K and F in 4.6 min. f.t.f.

In operation 3, a sliding tool holder in the center slide tool block follows tapered cam on bracket S, to generate 15° angle C, finish-bore D, finish-form E, chamfer G. Front slide tools finish-turn M-N-A, chamfer L. Rear slide tools finish-face P-B, chamfer Q in 3.6 minutes f.t.f.

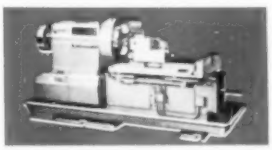
During operation 4, front slide tools finish-bore H, chamfer J; rear slide tools finish K-F in 4.6 minutes f.t.f.





Setup for operations 1 and 3. Note chucking method, cam S and follower stud at base of sliding tool holder for taper boring. Support R gives smoother finish, longer tool life.

Centralizing pins or chucking ring and six-point clamping eliminate chucking pressure distortion and improve accuracy, concentricity and parallelism. Sliding tool block locks in place for straight boring or follows cam S to generate accurate taper.



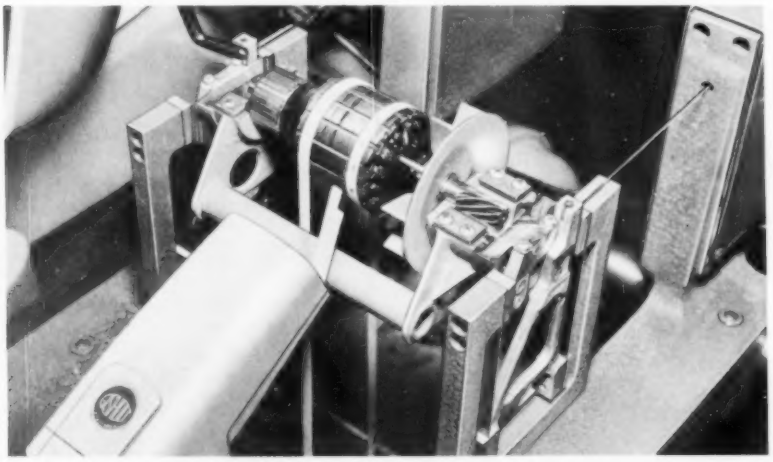
HOW BALANCING IMPROVES QUALITY AT AMERICAN ELECTRIC MOTORS, INC.

Setup eliminates guesswork on high-speed parts

You may find ideas in this 1S Balancer setup to help you improve your products. It's doing just that for American Electric Motors, Inc., a subsidiary of American-Lincoln Corp., Toledo, Ohio.

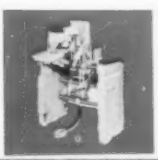
The workpiece shown is an armature, fan and drive gear assembly for a hand power saw and operates at speeds up to 10,000 r.p.m. Accurate balancing is a "must" for vibration-free operation and long service life. A cradle fixture is used to hold the work between the balancer supports. Although this increases the parasitic weight, the balancer's electrical system permits virtually infinite amplification of unbalance vibrations and accuracy is not impaired.

As the part is rotated, the operator notes the angle and amount of unbalance in each correction plane. The direct reading amount meter is calibrated in terms of the specific correction method used for each plane. This eliminates computation by the operator. The assembly is removed and the left end corrected by inserting slugs between the laminations. These are pre-cut and sorted by weight in handy trays for quick selection. The right end is corrected by a punch that removes the indicated amount of metal from the fan blade edge. Production is 25 parts per hour at 80% efficiency. This includes measurement, location, correction and inspection.



Cradle fixture permits this high-speed assembly to be supported on its own bearings even though the right-hand bearing journal is "hidden." Pre-cut metal correction strips, sorted by weight, save added time, minimize chance of operator error.

Gisholt balancing saves time, improves product quality because direct reading amount meter and strobe angle indicator permit finding exact angle and exact amount of unbalance the first time... eliminate all operator "guessing."



ASK YOUR GISHOLT REPRESENTATIVE ABOUT FACTORY-REBUILT

SUPERFINISH LENGTHENS LIFE OF AMERICAN RADIAL DRILL COLUMNS

Low-cost method to reduce abrasion—increases life of column and sleeve

MASTERLINE GISHOLT SINCE 1887

Compare this low-cost, quality-boosting technique with your present operation. Take a good look at the column on this radial drill, manufactured by The American Tool Works Company, Cincinnati, Ohio. It's Superfinished to expose the tough base metal for extra wear life—and smoother operation.

A Gisholt No. 4 Superfinishing Attachment is used, mounted on the carriage of a 40″ American Pacemaker Lathe. Carriage mounting provides longitudinal feed for the entire length of the workpiece. The part shown is 75″ long and 15″ in diameter. In only four hours floor-to-floor time, the ground surface is reduced from 32 to 4 micro-inches R.M.S.

Columns for the entire line of American Hole Wizard Radials are now Superfinished, using this simple, low-cost setup. Column lengths range from 46″ to over 100″ and diameters range from 9″ to 19″. Multiple stone holders permit Superfinishing over the keyways without difficulty. The "mirror" finish on the columns is achieved with a *controlled* diameter reduction of less than .001″.

Superfinishing minimizes lubrication problems and surface wear. Attachment costs considerably less than finish-grinding equipment—yet does the same job. And your lathe can be used for other work.

Low-cost Gisholt No. 4 Superfinishing Attachment mounts on lathe carriage... handles a complete range of column sizes.

All American Hole Wizard Radial Drills now feature Superfinished columns. This assures easier operation and longer life—a real sales point in today's competitive market.

GEAR FORGINGS MACHINED IN JUST ONE MINUTE

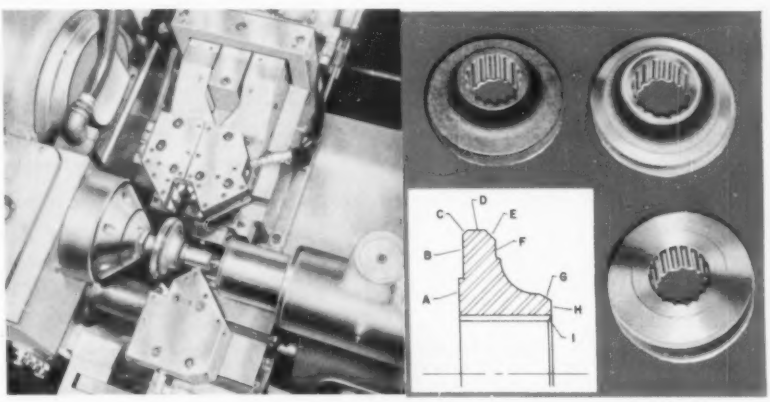
Smart setup includes arbor, loading cradle and straddle tooling

Here's how this tractor manufacturer makes simplicity pay big dividends—not only in time saved, but in improved quality. The parts are steel gear forgings—handled on a Gisholt No. 12 Automatic Production Lathe.

The part shown is $5\frac{7}{16}$″ in diameter, $1\frac{25}{32}$″ wide, with a spline broached in the I.D. The part is pressed in place on a supporting arbor and is located longitudinally in a fixture on the arbor press. This is done while another part is being machined.

The square end of the supporting arbor is centered and driven in a spindle-mounted fixture. To speed safe loading, a simple V-block loading cradle supports the other end while it is being picked up by the tailstock center. Front carriage tools turn D, chamfer G-I. At the same time, tools on the rear independent slide straddle-face B-F, A-H and chamfer C-E. A simple hydraulic arrangement moves the two rear slide tool blocks together for machining and apart for tool relief. Total f.t.f. time, just 1.0 minute.

Supporting arbor, loading cradle, straddle-facing tool blocks with hydraulic tool relief permit fast, accurate machining of front and back surfaces in one automatic cycle.



Overhead view of tooling and workpiece. Note square end of supporting arbor in work driver. Straddle-facing tools on rear blocks move together for machining, apart for tool relief.

Workpiece showing rough part and surfaces machined, front and back.

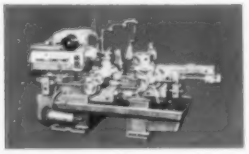
MASTERLINE
GISHOLT
SINCE
1887

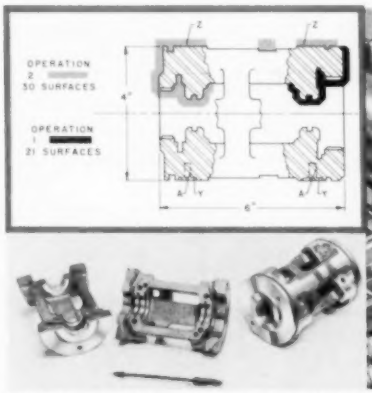
AIRESEARCH SLASHES TIME 35% ON CARRIER ASSEMBLIES

Hydraulic drive permits one operator to run two machines

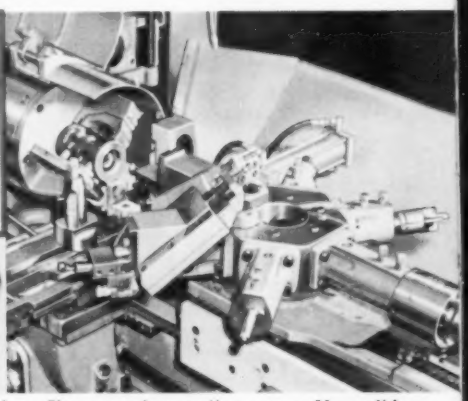
Here's proof that a small added investment in automatic controls pays big dividends. Study this setup used at AiResearch's Industrial Division plant in Los Angeles, Calif. It cuts machining time 35%, doubles operator productivity and improves accuracy on cast semisteel bearing carrier assemblies.

Two Gisholt MASTERLINE No. 3 Ram Type Turret Lathes are used. Hydraulic drive units provide automatic cycle operation. Spindle speed and feed changes, turret indexing and all tool operations are automatic, including work done from the cross slide. Forming, grooving and backfacing for both the first and second operations are handled by turret-mounted slide tools. On forward feed the movable slides engage a dead-stop cam on the cross slide and are actuated by continued forward movement of the turret ram. Reverse traverse provides automatic turret relief.





Workpiece consists of two sections, bolted for machining. Left—two halves, opened to show internal surfaces machined. Right—assembled to show external work.



First-operation tooling setup. Note slide tools operated by dead-stop cam at center of cross slide. Collapsing tap at right is recocked by cam block at rear of turret ram.

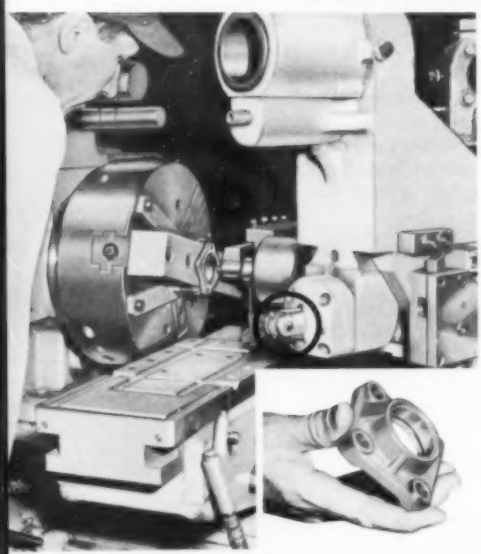
Parts consist of two mating sections bolted together. For the first operation, work locates on pins A against milled faces Y, on a fixed base. A swivel jaw holds at two points Z. Hex turret and cross-slide tools machine the 21 surfaces shown in black, including threading of the large bore, in only 2.5 minutes f.t.f.

Work then goes on the second machine. It is screwed on a threaded, drawback plug, locating against the machined face. The 30 surfaces shown in gray are finished from the hex turret and cross slide. Again, this includes threading of the large bore. Time, 4.35 minutes f.t.f.

Hand-operated machine with hydraulic drive becomes cost-cutting automatic. Operator simply loads, unloads and starts new cycle. Handles two units, inspects and stacks work.

HOW UNITED STEEL CORPORATION, LTD., CUTS COSTS ON PILLOW BLOCKS

Double-tooled Fastermatic and spherical boring tool speed production



Pillow block in two-jaw fixture and spherical boring tool (encircled). Inset, part showing surfaces machined in two-minute cycle.

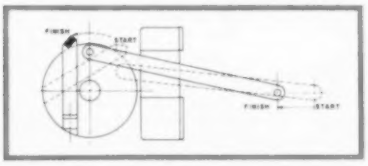
Here's a real time-saving setup for generating spherical bores in shell-molded pillow blocks to a .0005" accuracy. United Steel Corporation, Ltd., Toronto, Canada, is using it on a Gisholt 2F Fastermatic Automatic Turret Lathe.

The work is held in a two-jaw fixture—one jaw stationary for location, the other movable for chucking. It is bored through from hex 1. A slide tool on hex 2 forms a grease groove in the bore.

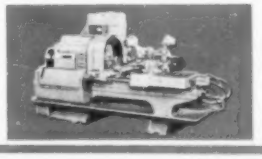
The top, movable portion of the slide tool on hex 3 carries the spherical boring tool and holder (encircled). The boring tool is linked to the slide base mounted on the turret face. On forward feed, the slide top engages a stop. The boring tool remains in a fixed position in relation to the work, while the slide base feeds forward, rotating the tool, generating the spherical bore (see drawing). A duplicate set of tools on stations 4, 5 and 6 finishes two parts with each turret index. Time, on a $2\frac{7}{16}$" pillow block, 2.0 min. f.t.f.

Six boring heads handle ten parts, ranging from ½" to $2\frac{15}{16}$". The tool in each head is set to gauge for various diameters within its range.

Single-point spherical boring improves accuracy and finish. Double-tooled turret permits longer runs between tool changes, saves time of indexing past idle stations.



Link attached to slide base feeds toward spindle, forces spherical boring tool holder to rotate, generating spherical bore.



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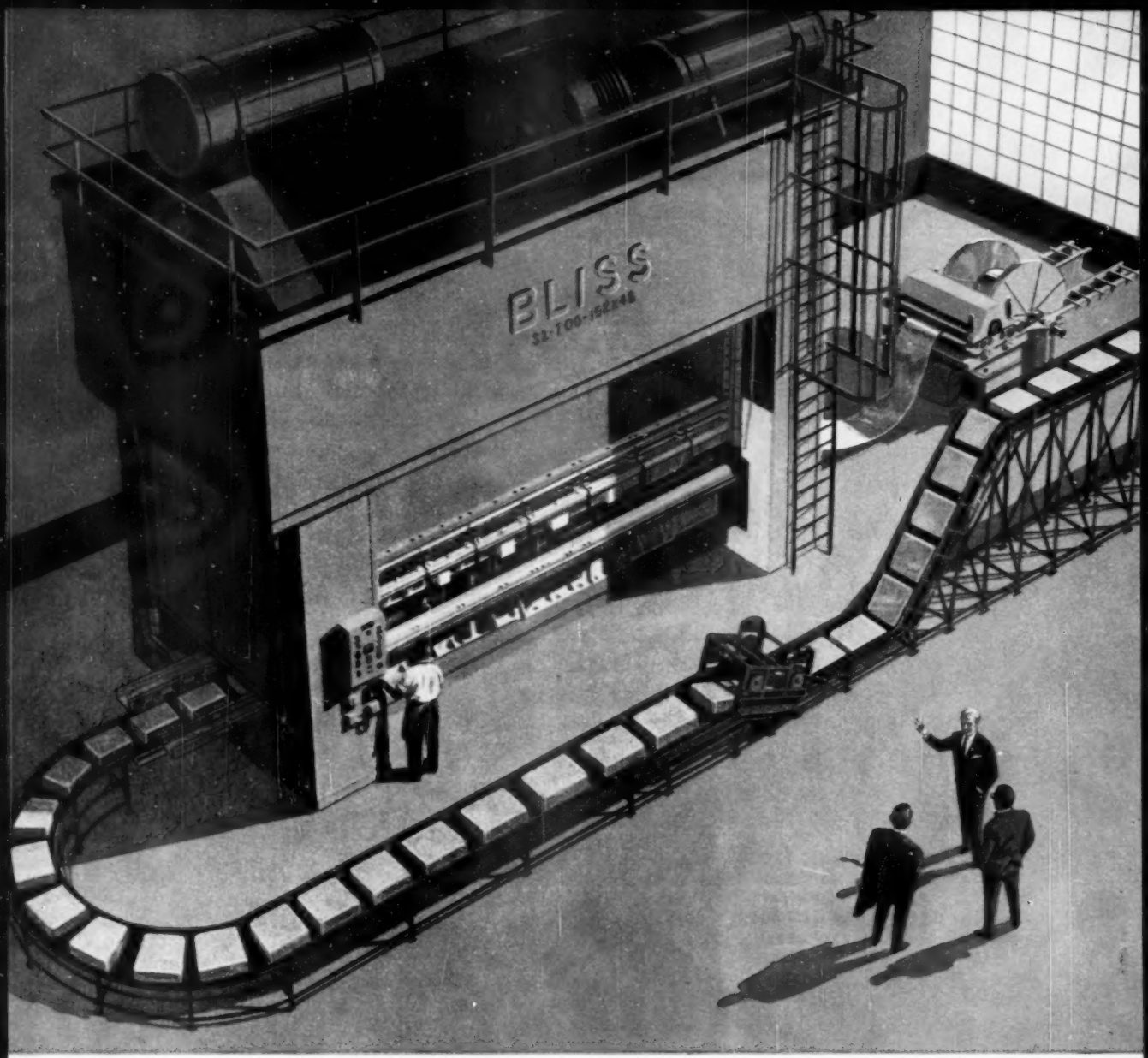

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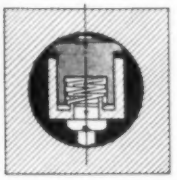

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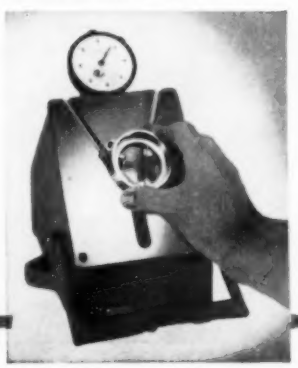

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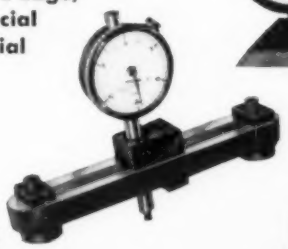

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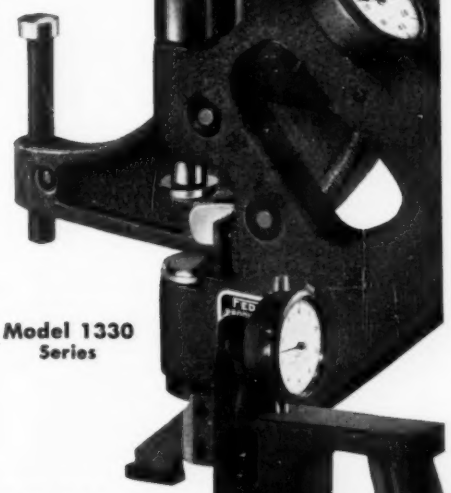

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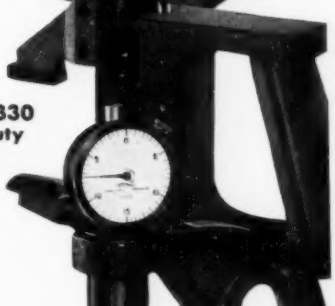

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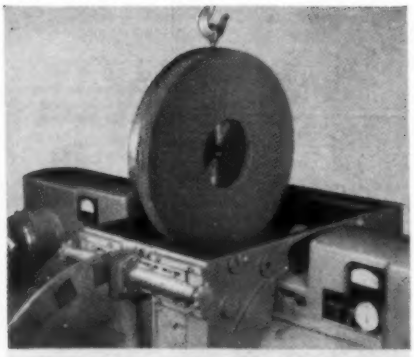

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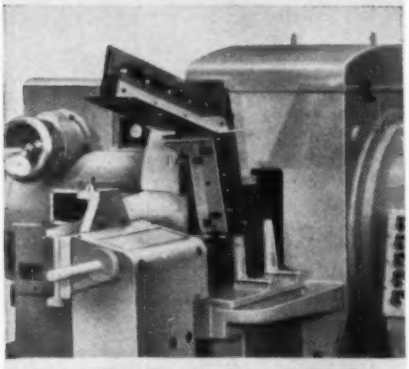

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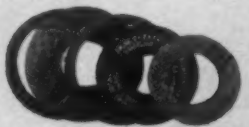

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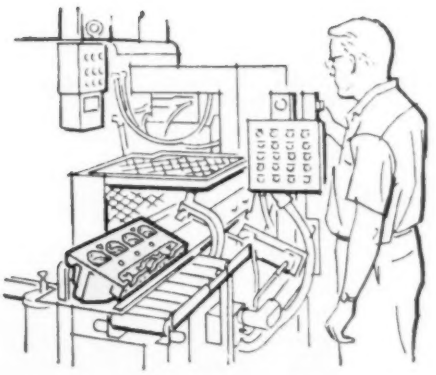

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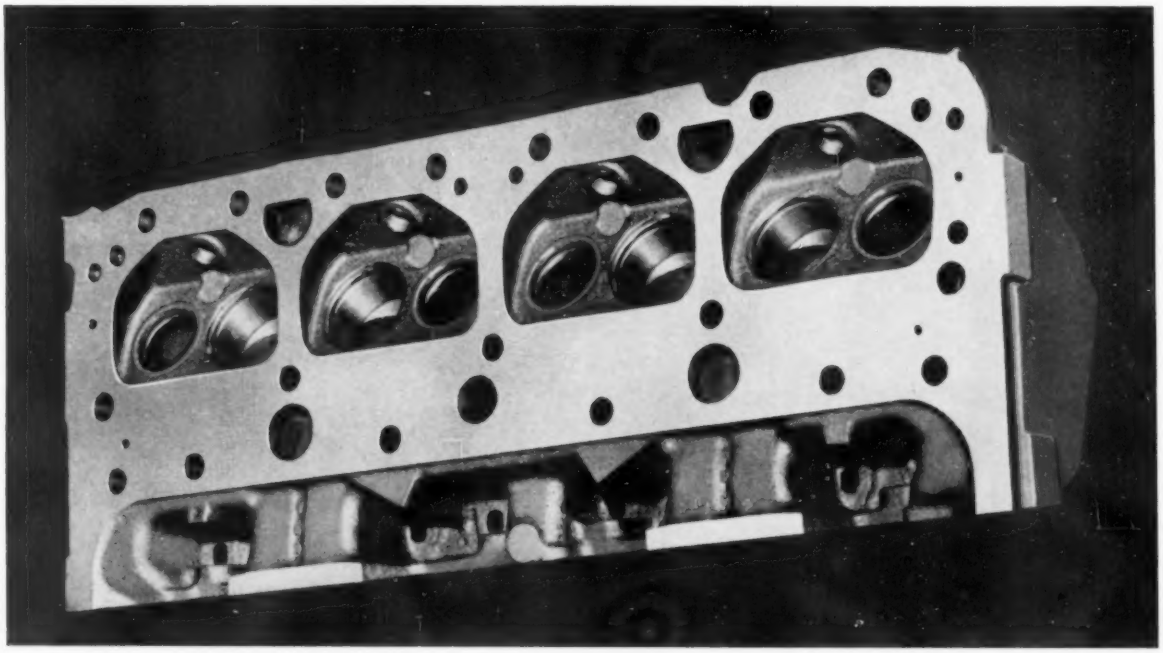

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Let's Wake Up!

Having recently been exposed to some alarming statistics on the shortcomings of our present educational system, I find myself disturbed and wondering about the possible outcome.

We have all read of the ever increasing need for more engineers and scientists. Our principal adversary in the present struggle for economic world leadership not only produces nearly twice as many scientists annually as we do, but keeps over 90 percent of them in that field as compared to our performance of about 25 percent retention. They are graduating annually at least one-third more engineers and keeping over 90 percent of them on the job, while we average little better than 50 percent.

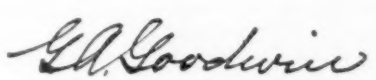
This differential is being accelerated. Yet people accept these facts with comparative complacency. Such apathy could lead to a rapid surrender of our freedoms quite early in this so-called "cold war."

A year or two ago we heard of a shortage of student capacity in the universities, but now we read of a probable over-capacity. Is this because we are not properly preparing students at the high school level? A sound structure requires a firm foundation and yet we find high schools requiring no mathematics beyond arithmetic at graduation. Only one state is reported to require any algebra.

Let's review our progress in the last half century. In 1908 nearly all state-controlled high schools demanded at least one year of algebra and 55 percent of all students graduated had this requirement. Today only 25 percent have it. In 1908, 15 percent had at least one year of physics against 4 percent now. Geometry is just as bad, and economics not much better. It would appear that some drastic action is needed to correct this situation if we expect our universities to turn out increasing numbers of qualified engineers and scientists. Progress appears to be backward.

I don't have a great white charger from which to launch a crusade but I invite every ASTE member and industrial executive to make his own investigation in his own community and take action where it will do the most good.

Yours for better education and a happy Holiday Season.



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Ledloy 170 Tubing vs. Nonleaded Tubing

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	Speeds	Feeds	Speeds	Feeds
Center drill	172 s.f.m.	.005"	110 s.f.m.	.005"
Form tool	172 s.f.m.	.0008"	110 s.f.m.	.0008"
Boring tool	172 s.f.m.	.007"	110 s.f.m.	.007"
Cutoff	172 s.f.m.	.0013"	110 s.f.m.	.0013"
Thread	27 s.f.m.	—	20 s.f.m.	—
Tap	18 s.f.m.	—	12 s.f.m.	—
Production time	35 seconds		49 seconds	

* As demonstrated at National Metal Show, Cleveland, 1958.

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SUCCESSFUL QUALITY-CONTROL OPERATIONS

By Edward S. Marks*
West Hartford, Conn.

Managers and engineers charged with responsibility of quality-control organization must be aware of principles which make for successful operations. This article enumerates elements essential to economical quality control and points out pitfalls to avoid.

GOOD QUALITY CONTROL is a valuable aid to reducing production costs and is the key to maintaining high product reputation. To realize the benefits from a quality-control system, it is necessary to recognize certain fundamental principles which have proved useful and successful.

Quality-control activity can be divided into four basic areas:

Planning production to produce quality

Planning inspection operations to prevent acceptance of substandard material

Carrying out inspection operations to comply with planning and to provide for the segregation of substandard material

Disposing of substandard material

Production Planning: The objective of the first area is to prevent production of substandard material, while the aim of the other three is to prevent its shipment. Production planning should be guided by the precept that to control quality best, responsibility for control of operations which, if not properly performed could result in production of substandard material, should not be divided.

The department which manufactures the product should be entirely responsible for producing not only scheduled quantity but also predetermined quality. The machine shop and assembly organizations must have under their control all the elements that produce high quality work. Hence, first-piece checks, periodic checks, floor inspections or any other quality controls of parts in process should all be under the control of production department supervision. If the department which has the scrap making potential is not quality-minded and is more interested in meeting schedules than it is in producing high-quality parts, then a successful quality-control program will be difficult to attain.

The primary objective of inspection department is to determine the quality level of finished products and advise the production department. It is the further duty of the inspection department to check properties of a part in process which cannot be checked nondestructively as a finished product, such as plating and welding.

In many shops planning of shop operations, including the selection of machinery, and the design and procurement of fixtures are functions of one group while another group is responsible for making equipment work properly, while still a third checks the work in process to see if quality goods are being produced. All these functions should be under the control of factory supervision. Then, and not until then, should an independent inspection organization take over and check the finished product against

*Mr. Marks was formerly Quality Manager of Pratt & Whitney Aircraft Div. of United Aircraft Corp. He is now retired.

specifications. If an independent inspection function conducted first-piece check or process control, the production supervision could easily say that the inspection department released the machines and thereby they themselves were relieved of any responsibility. One disadvantage of this limiting of responsibility might be the possibility of making a large number of defective parts more often than would be the case if an independent first-piece check were made. However, experience in many plants has shown this does not often happen. Even though it is not recommended that first-piece check and process control be placed in the hands of an independent inspection function outside of production, its importance in the prevention of scrap should not be minimized. There are many concrete examples of scrap reduction which have been obtained through these checks.

The more effective the process control is, the higher the quality level of the product will be at final inspection. In applying this same line of reasoning, the purchasing department must be responsible for the quality of purchased material and take the initiative in getting the vendor to take corective action when substandard material is received. The purchasing department must be made responsible for purchasing high-quality goods. The inspection department should furnish all the information necessary for the purchasing department to properly carry out its duties.

Planning Inspection: Inspection operations should be planned by a group charged with that responsibility and not left to be taken care of by production planners as an afterthought. This means that the inspection planners should have access to the drawings and specifications just as early as production planners. When it is decided to purchase parts from some outside source, the planning and procurement of equipment to properly inspect the material becomes the sole responsibility of the inspection planning group. The original planning at this point must be done independently of the vendor in order to have the inspection equipment available when parts are received.

When the decision has been made to manufacture rather than purchase, then selection of inspection equipment can best be done in collaboration with the tool engineering department. Where it is found that the production inspection equipment also satisfies the final inspection requirements, duplicates can be provided. However, in many cases, engineering requirements are such that some items of inspection equipment will be desirable even though they are not needed for production.

An important over-all function of the inspection planners is to ascertain how much inspection is required. How to inspect is, in many cases, no more important than how much to inspect. Some of the factors which must be known before the question of how much inspection is required can be answered are: method of production, including machine chart control; design of fixtures used to produce the part; quality level of parts previously inspected, and hand operations.

Another vital over-all rule that prevents errors is that an independent check should be made on each requirement. For instance, no operations should be performed by inspectors except those to determine conformation to specifications. If inspectors are allowed to perform any operations, such as placing identifying numbers on parts, and a mistake is made, it will not be found.

Where operations are large enough to do so economically, duplicate gage control personnel and equipment are desirable. For instance, one group maintains the accuracy of gages in the manufacturing department and another maintains the accuracy of gages in the inspection department. Gaging errors made by one group are almost certain to be found by the other.

Drawings do not always adequately explain quality requirements. Often, it is necessary to have approved samples available in order to know what is required. This is especially true where visual inspection requirements are a factor and are of a nature that cannot be measured. Many problems would be eliminated if there were no visual inspection requirements. Visual inspection often means fluorescent, Magnaflux, Magnaglow or X-ray procedures. These would be easy to handle if no indications whatever were acceptable. However, it is necessary to interpret just what can be accepted and what must be rejected and such standards are hard to describe. Decisions must be made based on what is known from testing experience.

Inspection Operations: In arranging the various groups, it must be recognized that inspection is a vital part of the over-all factory operation and must be so carried on as to assist in the movement of goods. In other words, the inspection operations are an integral part of the producing end of the business and should be so planned as to connect closely with the manufacturing operations. No more work should be in the inspection department than its normal share of the inventory. With these facts as a guide, care must be used to see that inspection stations are located to facilitate movement of material.

There must be close liaison between inspection and manufacturing supervision so that the production of large quantities of deviating material will be prevented. It has been found that the best results can be obtained if a full-time supervisor has not more than 20 to 25 inspectors working for him under medium working conditions. Medium means work that does not involve the inspection of large

quantities of duplicate parts, and where the inspecting group is concentrated in one location. About thirty can be supervised by one foreman if the work is repetitive and also concentrated in one location. Occasionally, especially on night shifts, inspectors might be found scattered over an area in groups of two or three. Under such circumstances, supervisors should not be responsible for over fifteen inspectors. It has been found to be effective if the foreman accepts full responsibility for the inspection operation under his supervision. He is usually assisted by two other groups, namely, gage inspectors and methods planners. If gages are not correct or if methods are not effective, the foreman still should be responsible. He should approve methods sheets before they are put on the job, and see to it that the gages and inspection fixtures do the job for which they were designed. He also must work with the gage inspection group to make certain that the equipment accuracy maintenance schedule is rigidly maintained. It is desirable to have each and every foreman recognize that it is possible for him to make final decisions on minor deviations without passing the material on to the special groups whose duty it is to dispose of it.

Disposition of Rejects: After all inspection operations have been performed, it is necessary to segregate all parts that do not conform to specifications. After parts have been found to be outside of tolerances, the amount of deviation must be determined. If the deviation is such that the part can be corrected to within allowable limits, it is sent back to the production department for corrections. This operation makes it necessary to have some universal measuring equipment available and also the class of help qualified to use such equipment. If parts were always made correctly, all of this activity could be eliminated. The higher the quality level of the material presented for inspection, the more economical that inspection becomes.

All parts that can be easily moved must be protected while waiting disposition. This is necessary in order to prevent them from accidentally getting into the same stream with accepted material. The decision which has to be made at this point is either "accept," "return for repair" or "reject."

Rules and regulations which govern these decisions can be of only the most general character. The manner in which these decisions are made is an important factor in the maintaining of over-all quality at a high level. The fact that a part has been accepted once before with a certain deviation can never be used as a reason for continuing to accept. If such a rule were used, the tolerances might just as well be changed on the drawing and then sooner or later work would begin to be received outside of the new tolerance. Then there is the possibility of learning that parts accepted with certain deviations at some time in the past have turned out to be troublesome to such an extent that no more of such material should be accepted.

In this operation where there is the possibility of rejection, speed is essential. If large amounts of work are to be scrapped, they must be replaced at once or the lack of them will interfere with schedules. No pressure for acceptance of substandard material from any source can be tolerated. However, inspection cannot take long to decide whether or not to accept.

Efforts made to finally dispose of deviating material must be based upon a knowledge of the func-

Many times it costs more to repair parts than it does to throw them away.

Manufacturing departments should be responsible for quality as well as quantity.

tioning of a part. If such knowledge is not available within the inspection department, it must be sought among those responsible for the design. Many times, it is possible to hold parts until other parts with the same dimensional or visual deviations have been tested. An intelligent decision can be made based upon those tests.

Any decision made to repair a part so that if, after such repair, it is not as specified, must be finally approved by the group which originally designed the part. Such repairs should be controlled by special drawings properly approved by the designing engineers. When these repairs involve dimensions inside an assembly, these same dimensions must be checked by inspectors during the progress of the repair work. Many times, it costs less to throw away parts than it does to satisfactorily repair them.

Each week, one afternoon should be devoted to a conference where materials with deviations are laid out for the inspection of supervisors in the shop and production engineers. The reason for each error is discussed and corrective action decided. Minutes of the meetings retain a record until corrective action has been taken. Charts showing quality trends should be used in these meetings also. These charts show variations in such items as percentage found with deviations and percentage of the work finally rejected.

Costs: It is not possible to adequately discuss the management of quality control without mentioning the cost of all of these activities. Budgeting or estimating the costs in advance presents many problems. The lower the quality of the work presented for inspection, the greater the cost because a large part of the overhead of an inspection department is concerned with the segregation and handling of deviating material. For this same reason, the cost of quality control is always greater when new designs are being put into production and a larger percentage of deviating material is usually found. Certain ratios have been found to be an effective guide in determining reasonable costs if records of them have been kept for some time in the past. Some examples of these ratios are:

Direct inspection labor to indirect inspection expense
Total inspection cost to total cost of goods shipped
Cost of inspection vendor material to cost of vendor material
Direct manufacturinig labor to cost of inspection of parts produced by that labor

Personnel: All the labor of elaborate planning and the most diligent conformance to the plans will be effective if the individual inspector does his job properly. To be assured that each inspector does just that is still one of the most important factors in the success of any quality-control operation. In bringing about this assurance, the foreman is still the key man. He should be assisted in this task by use of special training courses covering specific jobs to be done. Of course, inspectors must be selected with care.

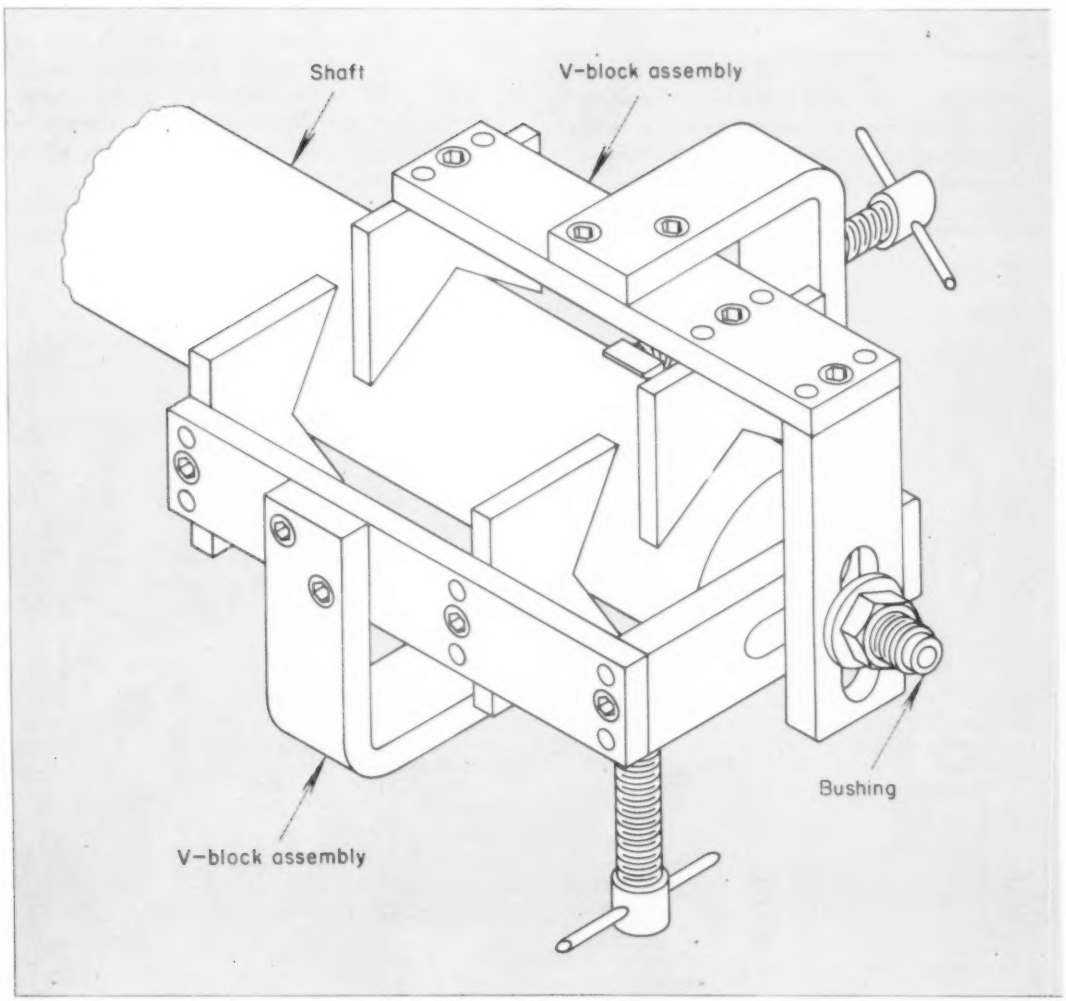
Training is only the beginning of trying to create the inspector's interest in his work. The real problem is to keep up interest in that work. For this there is no substitute for personal contact. It is vitally important to have a foreman actually discuss some phase of the work with an individual inspector at least once a day. No inspector should be allowed to go home at the end of the day's work without having had oral contact with his superior. A lack of interest on the part of a supervisor begets lack of interest on the part of workers.

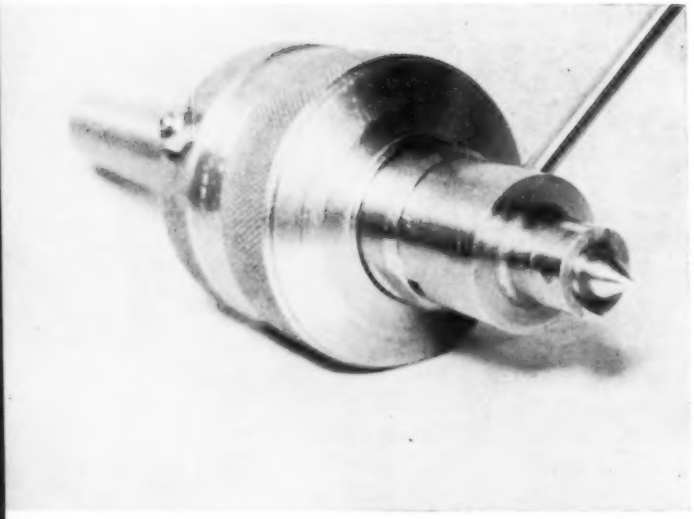
Centering Fixture

Drilling center holes on large shafts can be a time-consuming operation. The usual procedure is to set the shaft up in a steady rest and indicate the correct hole loation. The fixture shown was designed to expedite this operation.

It consists of two V-block assemblies, each attached to the shaft with a C-clamp. Slots in the end members of both assemblies are aligned with the center lines of the V's. A hardened bushing fits into the slots as illustrated. After the fixture is clamped in place, the center hole is drilled with a center drill brazed to an extension, using a portable drill.

Ernest Jones
Bronx, N. Y.





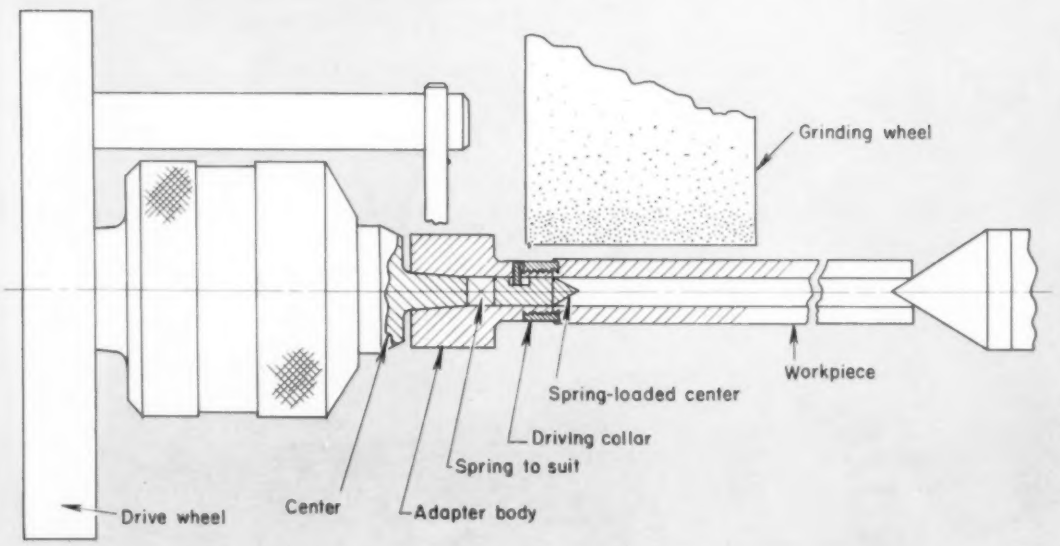
Contributions for these pages describing short cuts for the tool engineer are welcome. Finished drawings are not necessary. Payment for accepted articles is made upon publication.

End Driving Adapter

When grinding the OD of revolver barrels and similar parts, the conventional method of "dogging" from the OD is costly and grinding wheel wear is excessive. The end driving adapter shown was developed to permit end-to-end grinding and loading and unloading of the workpiece without stopping the drive wheel.

The adapter has a spring-loaded center that is retained by a setscrew. A driving collar screws onto the adapter body. Cross holes permit easy removal with a spanner wrench. Two driving teeth are provided on the driving collar illustrated, but the number of teeth can be varied to suit requirements. This adapter has given good performance and has reduced grinding wheel wear.

Alfred Thibodeau
Worcester Chapter

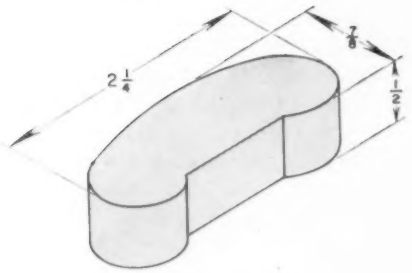


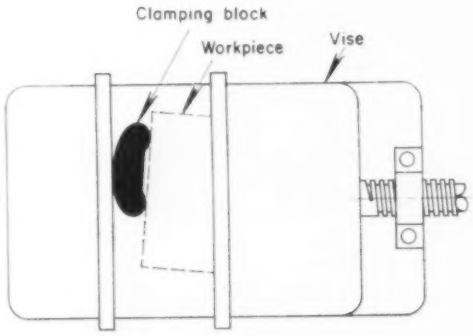
Gadgets

Clamping Irregular Stock

When bar stock is cut off with a saw, one or more sides may not be square. To facilitate holding the stock in a vise for milling, grinding or shaping, the clamping block illustrated has extended bearing points and a curved back. Dimensions shown on the drawing can be altered to suit job requirements. For most applications, the block can be of cold-rolled steel.

Detlef Schilling
Toronto, Ont.





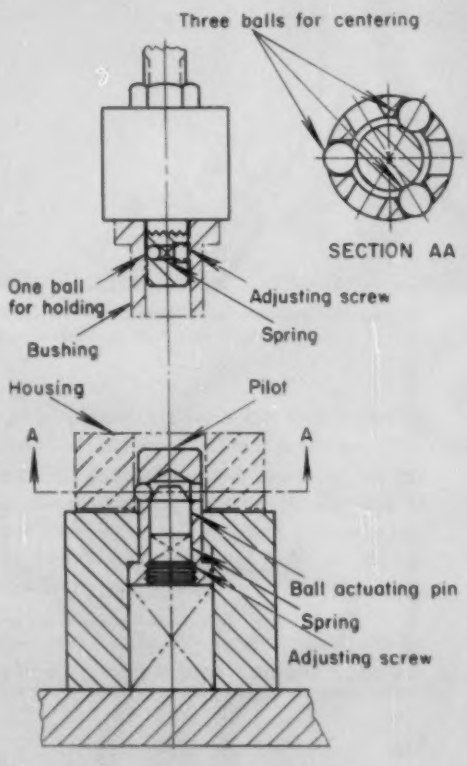
Pressing Fixture

Balls are utilized for both holding and centering in the pressing fixture illustrated. The operation involves pressing a bushing into a motor housing. The bushing fits over a ram adapter ground from 0.001 to 0.002 inch smaller than the minimum bushing hole diameter. A ball in the adapter extends 0.010 to 0.015 inch beyond the pilot diameter. Spring pressure on the ball holds the bushing in place during the downstroke of the ram.

To compensate for the large tolerances and rough finishes of the housing, the three-ball centering device illustrated was designed. The pilot is made from 0.010 to 0.020 inch smaller than the minimum hole size. The balls extend 0.010 to 0.015 inch beyond the pilot diameter. As the bushing is loaded onto the pilot, the balls automatically center the part.

The centering action is caused by a spring, which pushes on an actuating pin. This pin pushes the balls outward evenly, exerting the same force on each ball. A solid pilot would allow the part to drift off-center by an amount equal to the tolerance of the hole.

Joe Donofrio
Toledo Chapter



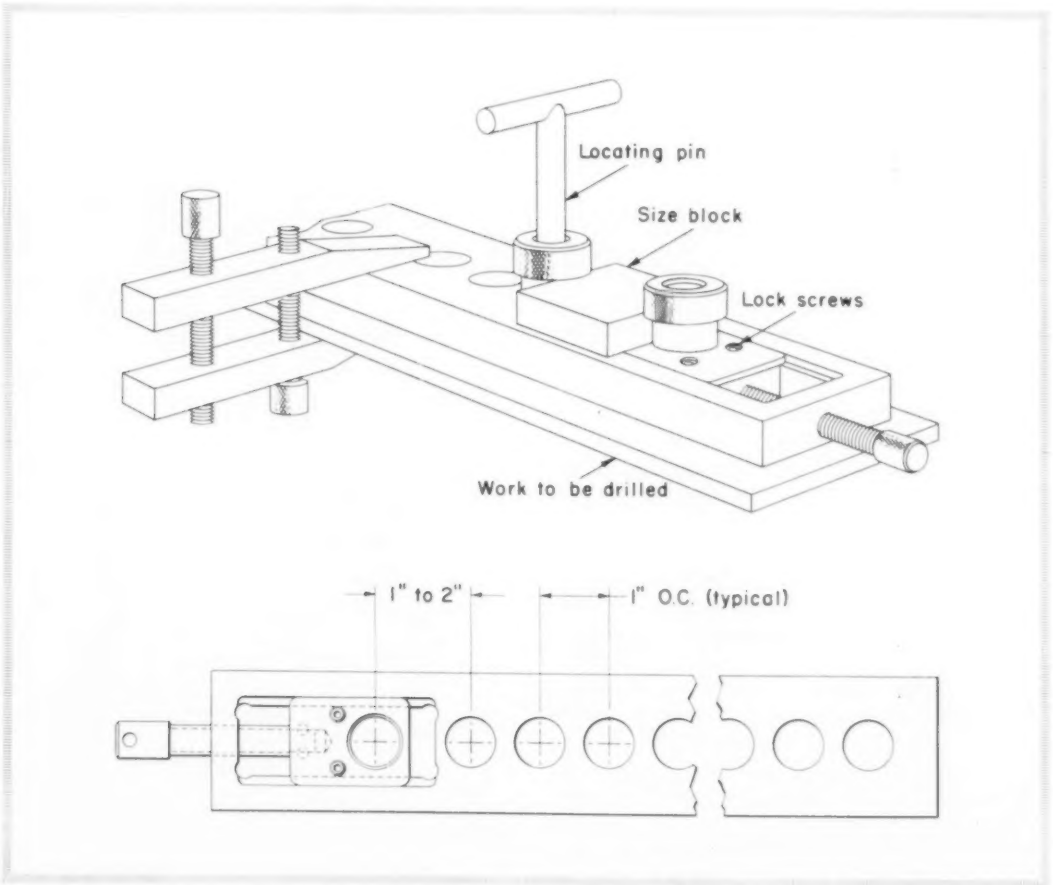
Master Drill Bar

Aircraft tool production has been expedited and expensive jig boring operations minimized by using the master drill bar illustrated. The bar is machined from Meehanite Grade GB. This material is free machining, tough, wear resistant, and extremely stable. A series of holes are jig bored on one-inch centers to receive slip renewable drill bushings. Elimination of liner bushings and bushing lock screws has proved practical and reduces the cost of the master tool. A hand-fitted sliding block with a locking plate is employed to alter and set the position of one hole. A heat-treat operation is used to reduce residual or induced stresses, thus insuring stability. A flash cadmium plating protects the tool and enhances appearance.

In practice, this straight adjustable type of master bar may be positioned to locate those holes having a common center line or a known dimension between hole centers. With precision-ground blocks or other types of measuring tools, the sliding block may be set to any decimal position between one and two inches. To this setting some multiple of the one-inch spacings is added to achieve a desired dimension. Currently, bars from 7 to 52-inch lengths have been successfully used.

To drill or ream the required holes, the first hole is produced without the bar. Using a precision dowel or pin in conjunction with this datum hole, the master bar is positioned and clamped to the work. With an appropriate drill bushing, the subsequent hole or holes may be drilled to 0.0015 inch accuracy. Grumman Aircraft Engineering Corp. has estimated that use of the bar has resulted in $30,000 annual savings.

Victor Olson
Long Island Chapter



Building-Block DESIGNS reduce tooling costs

By Ralph E. Cross*
Executive Vice President
Cross Co.
Detroit, Mich.

With keener competition developing for markets at home and abroad, versatile production machines that may quickly and readily be modified for model changes become increasingly important. Standard building-block units of the type described in this article may provide part of the answer, offsetting rising costs.

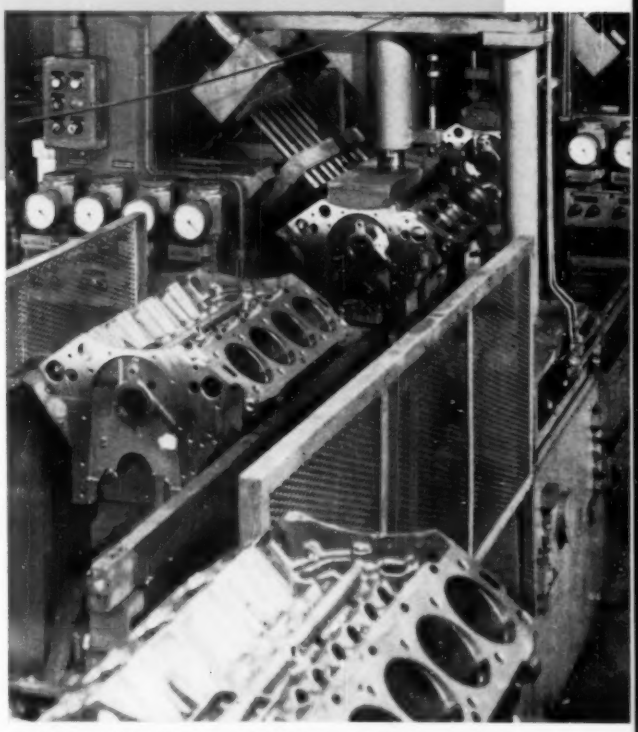


Fig. 1. Building-block section of machine for gaging valve lifter holes for diameter and taper.

TODAY'S MOST PRESSING NEED in automobile production is for machine tools that will provide for faster and less costly model changes. To fulfill this need, a sectionalized transfer machine for engine blocks, *Figs.* 1 and 2, was designed with new concepts of flexibility.

The machine is constructed around "building blocks" designed to conserve capital investment when it becomes necessary to make substantial changes in the product. All machine parts, even small tooling details, have been made to interchangeable tolerances so that change-overs can be accomplished in the shortest possible time.

The machine is composed of seventeen independent sections that stop and start automatically as workpieces are made available for each series of operations. In all, the machine performs 2291 operations simultaneously while working on 390 parts in process. Rated capacity is 350 engine blocks per hour when the machine runs continuously. In operation, however, sections of the machine must be stopped from time to time to change tools.

Machine control units, *Fig.* 3, are strategically located at thirty-seven positions throughout the ma-

*Senior member ASTE Detroit chapter.

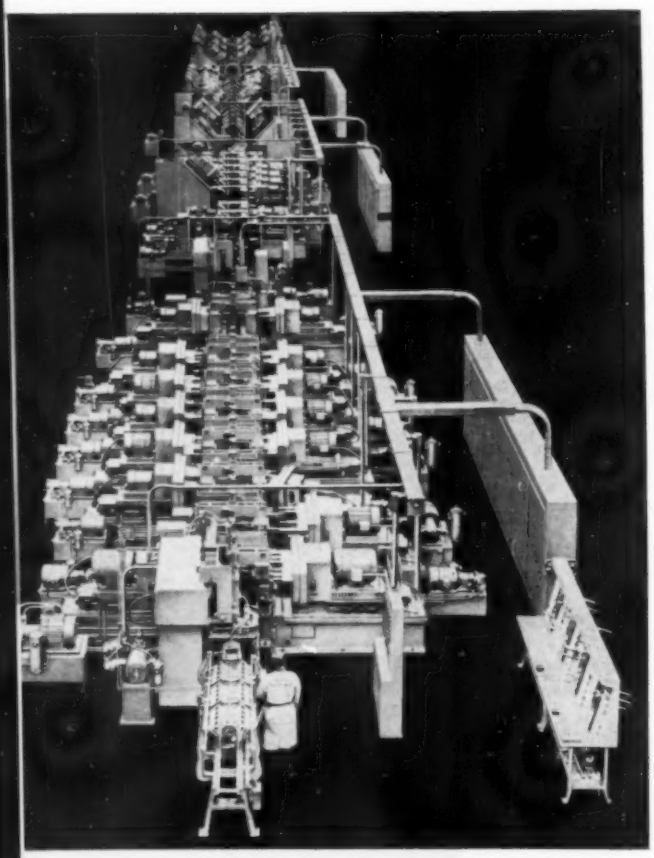


Fig. 2. View showing four sections of the building-block transfer machine.

chine to program tool changes. Spare, preset cutting tools and holders are stored in the units near the point of application, where they will be readily available when the control boards signal the job setters that tools need changing.

An example of the building-block design is the base and transfer mechanism which is standard throughout the machine. Identical center bases are found at each work station with standard hole patterns for fastening fixtures to the top and wing bases to the sides. *Fig.* 4 shows one of the center bases and the standard hole pattern for adjoining a wing base. Feed units, wing bases, heads and fixtures can easily be moved from one station to another without any changes to the center bases or the machine foundations.

All center bases are equipped with lift arms for the lift-and-carry transfer mechanisms. Standard transfer bars, made in single-station increments, are spliced together for the desired length. Replaceable nests for carrying the parts from station to station are bolted and doweled to the transfer bars. A wide variety of part configurations can be accommodated with special part nests.

Part movement from section to section is accomplished with standard shuttle conveyors. Between some sections accumulating conveyors provide automatic banking as, for example, between Sections 5 and 6, *Fig.* 5. Here the material flows from three lines into two. A shuttle conveyor receives the material from the three No. 5 Sections, and feeds two accumulating conveyors, which in turn feed the two

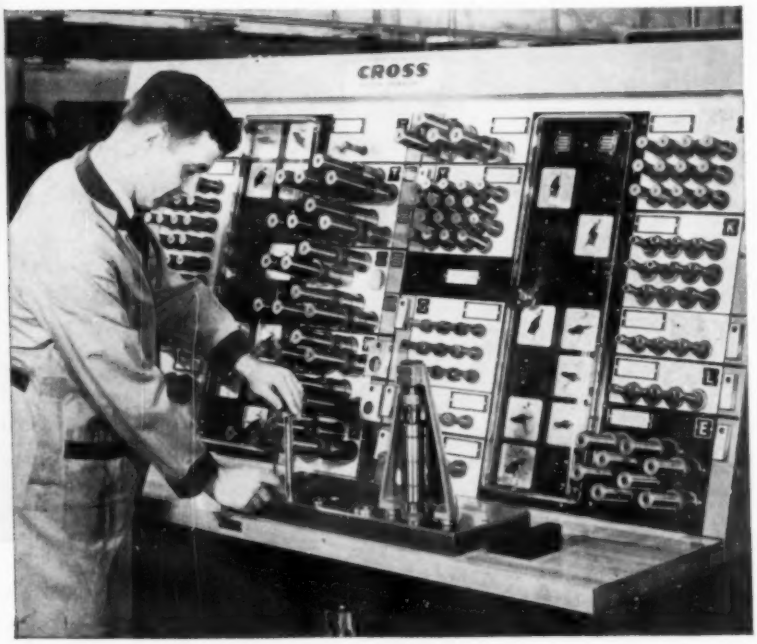


Fig. 3. Machine control unit programs the tool changes. Thirty-seven such stations are employed at convenient locations.

No. 6 Sections on demand. If the No. 5 Sections are feeding more parts than the No. 6 Sections can immediately absorb, then the conveyors store the excess. The component parts of the shuttles and accumulators, such as the escapement mechanisms, guide rails, brackets, etc., are standard so that units can be rearranged to accommodate a variety of plant layout conditions.

Other examples of the building blocks are four standard workholding fixtures, which are referred to as Fixture A, B, C and D. Fixture A holds the block in an inverted position and is designed for the pan rail and underbank operations. Fixture B holds the block crossways for the end operations. Fixture C holds the block on its side for the top and bottom operations, and Fixture D holds the block in car position for the operations on the banks and the valve lifter holes. Each fixture has capacity to handle a wide range of part sizes. By changing locating pins, clamp members and bushing plates, the fixtures will accommodate any V-8 block in the automotive industry.

Three standard work handling devices have been developed to orient the blocks for the different fixtures. The handling devices provide:

1. A lateral movement and 180-degree flip-flop
2. A lateral movement and a 90-degree index
3. A 90 or 360-degree rollover.

With these three orienting devices, the blocks can be positioned for any operation that might have to be performed on them. *Fig.* 6 shows the work handling device for rolling the block 90 degrees from side to car position.

Operations performed on the blocks in the six machine sections are as follows:

In the first section, the blocks are bottom up and operations are performed on the underbanks and the pan face. Transfer spots are also machined at this point for subsequent sections. At the end of the section, the parts are turned over and presented to the second section, which turns them 90 degrees so the ends are exposed for machining. As the parts progress through Section 2, all holes are drilled in both ends, including the three oil gallery holes. The camshaft bearing diameters are also rough bored, and at the end the blocks are again turned 90 degrees and placed in car position.

In Section 3, the blocks are turned up on their sides and the unfinished holes in the bottoms are completed as well as the drilling on the tops. The distributor and breather holes are also bored in this section. The parts are then turned back into

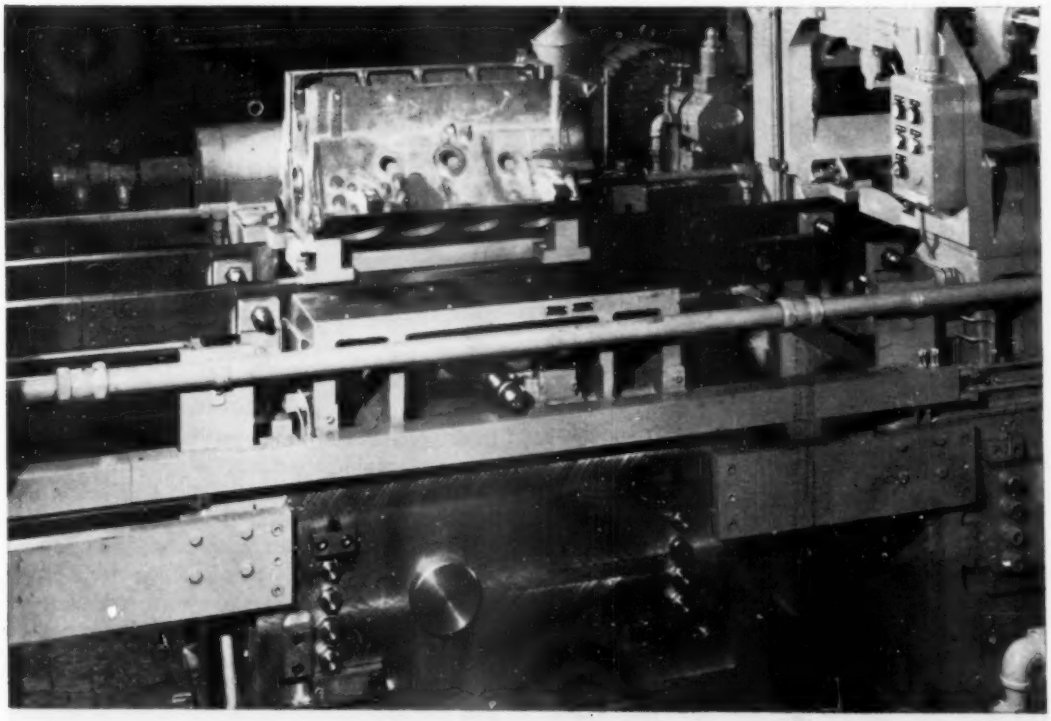
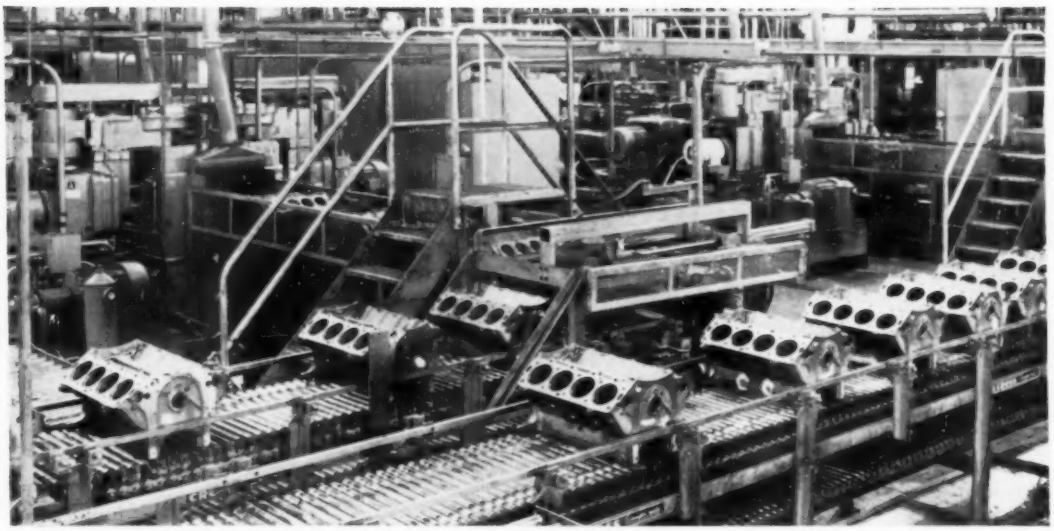


Fig. 4. All center base sections in the line are standard and are machined to receive standard wing bases and fixtures.



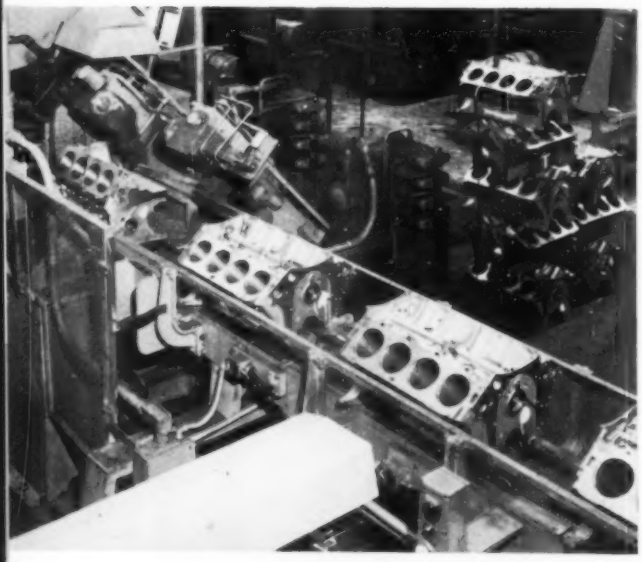


Fig. 5. (above) Accumulating conveyors with free running rollers automatically bank the parts ahead of the tapping machines.

Fig. 6. (left) At the end of Section 3, a standard rollover unit turns the part from side to car position.

car position, and presented to Section 4, which mills the engine mounting pads and drills the cylinder head bank faces. In the latter part of the section, the deep oil holes that feed the oil to the cylinder heads are drilled.

The part remains in car position as it goes into Section 5, which is devoted entirely to the processing of the valve lifter holes. Here the holes are drilled, rough reamed, finish reamed and inspected. The air gaging units for the in-process inspection of the valve lifter holes are shown in *Fig.* 1.

Section 6 performs all the tapping operations. The parts enter the line with the ends exposed and are repositioned to car position part way through for the bank tapping operations, and then to bottom up for sides and pan rail tapping. All holes are probed after tapping as a final inspection measure. Parts leave the line bottom up ready for the assembly of the bearing caps.

The machine weighs $3\frac{3}{4}$ million pounds and occupies an area of 34,000 square feet. It is powered by 496 electric motors developing 3750 hp.

This machine is indicative of the type of automatic processing equipment in current use. However, the flexibility of the unit for changeovers to new models permits extended life from these specialized machine tools. It may well foretell the future of the special machine tool field.

Challenge in Production

Unfolding some surprising statistics, Ralph J. Kraut, president of Giddings & Lewis Machine Tool Co., warned industrialists that both Russia and Western Europe are exceeding the United States in machine tool production. Mr. Kraut, speaking before the Machine Tool Distributors' Assn., pointed out that Russia is exporting about 20 percent of her 125,000 machines built each year, and they are priced according to political rather than economic considerations. While U.S. production amounted to about $1,100,000,000 last year, Western Europe and England produced the equivalent of $1,200,000,000. Accomplishing this output are more than 1000 machine tool builders in Western Europe, and only about 300 builders in the United States.

automatic

TOOL CHANGING ...cuts setup time

By George O. Philip*

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Endicott, N. Y.

Often machine setup represents the highest single cost in manufacturing. Automatic changing of tools provides better machine tool utilization and may effect smaller inventories, reduced material handling and other worthwhile savings.

AUTOMATIC SETUP OF MACHINE TOOLS, *Fig.* 1, controlled by a predetermined program, presents an effective method to reduce setup time. When applied to machine tools, this process is called numerically or digitally controlled machine tool automation. In order to fully benefit by reduction of setup time, each step in the manufacturing process must be automatically controlled.

In the manufacture of side frames, *Fig.* 2, for example, the most expensive operation is the boring operation. Setup for each lot of frames is time consuming and the machining is tedious. To overcome these production difficulties, the digitally controlled boring machine shown in *Fig.* 1 was developed. Information representing the required variable machine functions is stored in a convenient storage medium such as a punched card. The machine functions are:

1. Table positioning
2. Tool selection
3. Speed and feed selection
4. Depth of cut selection.

In conventional manual operation of a boring machine, mistakes are common because of the repetitive nature of the boring operation. The wrong hole may be presented to the tool, the improper tool may be selected, and incorrect cutting speeds or feeds may be used. The transfer of the repetitive decisions from the man to a storage medium insures exact duplication of each step.

Problems in Tool Changing

The boring operation has always required a high degree of manual skill to insure quality performance. It was assumed that no machine could repetitively insert a toolholder into a spindle with the accuracy of the skilled operator.

Because tool changing represented one of the last links to a complete mechanical process, it was felt worthwhile to investigate the problems of automatic tool changing. When considering the problems of tool changing, the following steps should be defined.

* **Senior member ASTE Binghamton chapter.**

Fig. 1. (right) Digitally controlled boring machine.

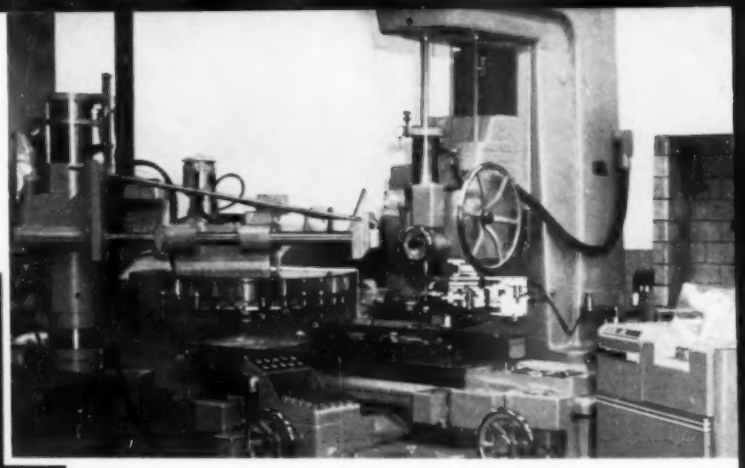
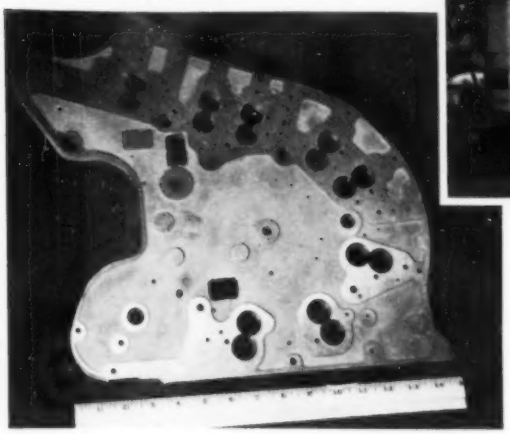


Fig. 2. (below) Typical piece part produced on boring machine.



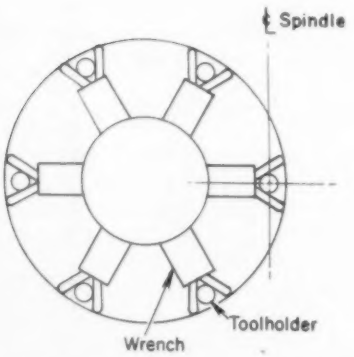
1. The toolholder must be removed from the boring spindle
2. The removed toolholder must be stored in a definite position
3. The next required toolholder must be selected
4. The selected toolholder must be presented to, inserted into, and properly tightened in the spindle
5. Tightening must be achieved with unfailing precision
6. The complete operation must be safe and reliable.

Tool Changing: The characteristics of the whole system must be considered in the development of a tool storage device and a wrench mechanism. One possibility suggests that each storage station be equipped with its own wrench, *Fig.* 3a. If thirty tools were stored, this would require a complex and costly system.

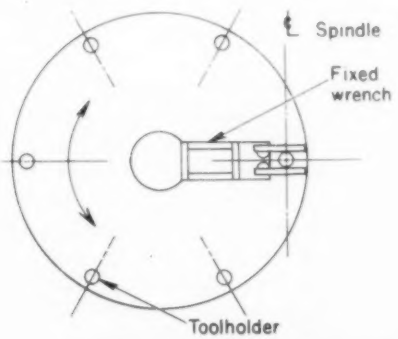
A more economical approach is a single wrench station mounted on the tool storage device and concentric with the spindle opening, *Fig.* 3b. The selected toolholder is moved to this station. However, insertion of the toolholder into the spindle cavity requires some vertical motion of either toolholder or spindle. This idea was rejected because of difficulties anticipated in precise alignment tool changer, wrench station and spindle.

By mounting the wrench device separately on the boring machine, allowing the tool storage device to present the requested tool to the wrench, and then letting the wrench do the inserting, all the required steps can be accomplished quickly and economically, *Fig.* 3c. Before this last approach can be accepted, however, more information regarding the toolholder should be known. As a starting point, the shapes, sizes, and accuracies of commercially available boring machines and toolholders must be investigated.

Fig. 3. Tool storage device with different wrenching combinations.



a. MULTIPLE WRENCH MECHANISM



b. SINGLE WRENCH MECHANISM

Toolholding: Boring quills generally consist of a spindle to which some form of toolholder is attached. Toolholders are of many types and designs depending on the function that the spindle is to perform. Drilling quills are usually equipped with self-centering variable diameter chucks which either are inserted into a suitably tapered hole in the spindle or are permanently fastened to it. Boring quills, whose requirements for accuracy are more stringent, are equipped to accept boring toolholders which align themselves consistently and accurately with the spindle.

Three major types of toolholders are used in boring spindles: the straight shank, the tapered shank, and the nonsticking tapered shank. Each depends on some tightening device to draw it into the spindle against an accurately machined surface.

For automatic tool changing, toolholders must be portable, self-signing, and easily secured. After extensive study of commercially available toolholders, the Moore toolholder was selected, *Fig.* 4. This holder has a nonsticking taper shank, the smaller end terminating in Acme type thread and the larger end joining a hex nut. Next to the nut is a cylindrical, knurled spacer used to grasp the holder. A hole, in which drills or precision boring chucks can be mounted, runs through the axis of the spacer. To change toolholders manually, the holder is loosened by using a wrench on the hex nut and turning the toolholder clockwise until the threaded part has been unscrewed from the spindle. The new toolholder is inserted and screwed into the spindle until the external taper of the toolholder matches two accurately machined rings on the internal taper of the spindle. An additional twist of the wrench secures the toolholder to the spindle. Alignment of the toolholder with the spindle depends on the torque produced by the wrench.

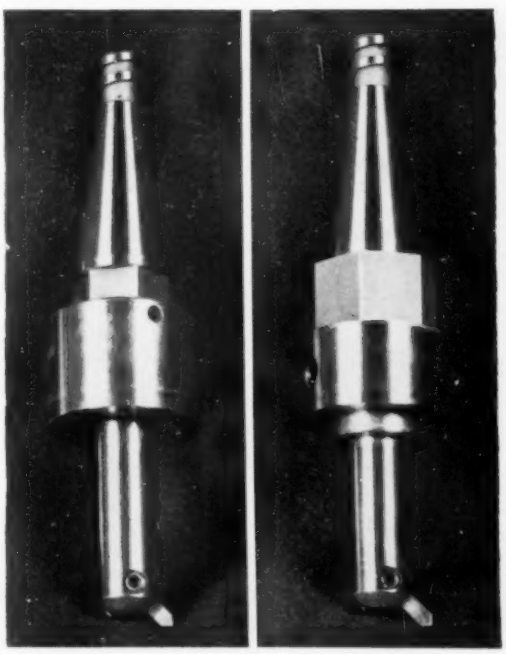
Mechanical handling of the toolholders requires that certain dimensions be standard from toolholder to toolholder. On the Moore toolholder, the hex nut and its location from the cylindrical spacer is standardized. This allows the wrench device to contact the hex nut at the same height for all toolholders, *Fig.* 4.

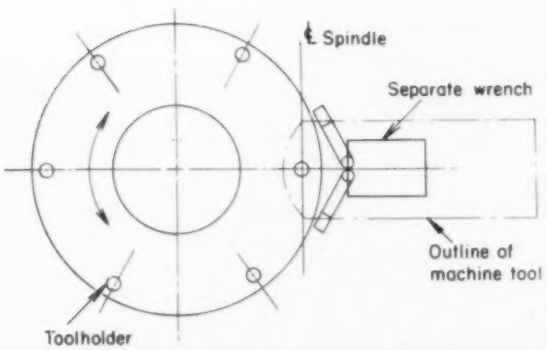
Tool Storing: Different ways in which toolholders can be stored in a device for automatic selection are shown in *Fig.* 5. These are dependent on the method employed in locating a particular toolholder under the center line of the spindle. The rectangular coordinate method, *Fig.* 5a, locates each toolholder with reference to two mutually perpendicular axes. The storage device moves along two axes, driven by two servo drives, controlled from commands stored in a storage medium. The polar coordinate method, *Fig.* 5b, locates each toolholder with reference to a radius and an angle. The selected toolholder is rotated into position through a drive controlled from commands stored in a storage medium. The selection of either method depends on the shape of the boring machine being used.

Boring Machines

Boring machines are either vertical or horizontal, depending upon the position in which the spindle is mounted. Vertical machines are usually used

Fig. 4. Toolholders with standard spacers. Holder (left) is modified to have large hex nut for the wrench on the new holder (right).





c. SEPARATE WRENCH MECHANISM

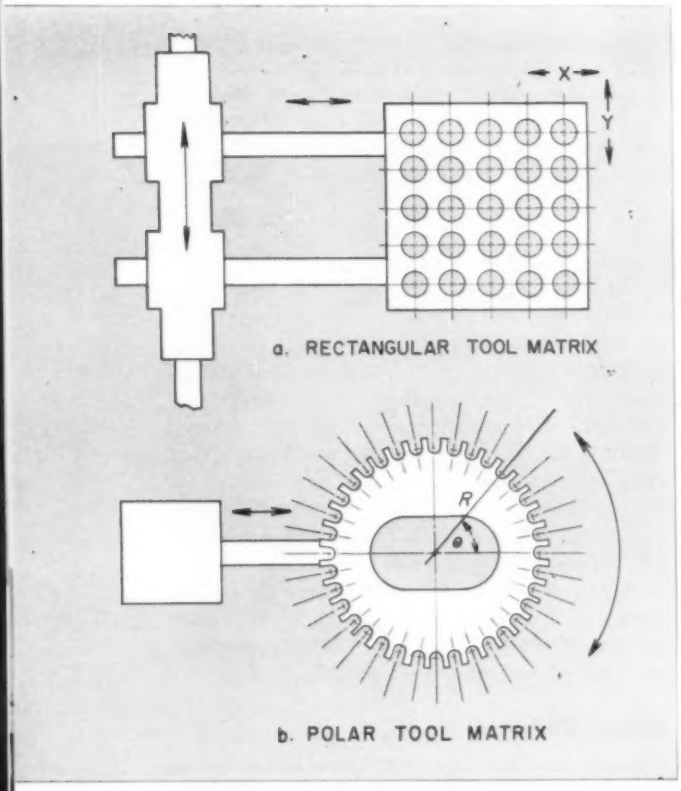


Fig. 5. Rectangular and polar types of tool storage.

with parts that are more easily located horizontally than vertically. In the case under study, the vertical boring machine is used. All secondary tooling is adapted to this condition. Vertical boring machines are grouped into several types: C or column type, H or bridge type, and cantilever types.

The column type boring machine supports the spindle on the main column of the machine insuring stable location of the spindle. Table and cross-slide move normal to the spindle in X and Y coordinates. The bridge type machine places the spindle on a bridge located above and at right angles to the table. The table moves in one direction, say X, and the spindle moves across the table on the bridge in the Y direction. The cantilever type boring machine supports the spindle mechanism at the end of a short cantilever. A two-dimensional table is located normal to and underneath the spindle.

Considerations for Tool Changing

When automatic tool changing is applicable, the following is considered:

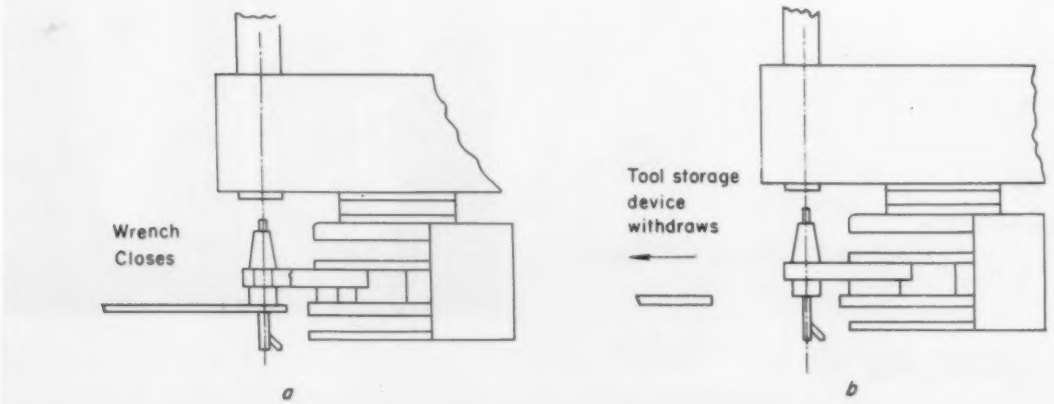
1. Number of tools to be changed
2. Shape and size of the boring machine
3. Effect on maintenance
4. Normal work area of operator.

Item 1 establishes the general size of tool changing equipment for either polar or rectangular methods. For the polar method, this size is dependent on the number of tools to be stored and the clearance between the wrench and the adjacent toolholders. The more tools to be stored, the larger the diameter of the table. If 60 tools were to be considered for automatic tool changing, then the over-all size of the tool storage device might be prohibitive and the rectangular method preferred. If, however, 30 tools or less are to be changed, the diameter of the storage plate is of secondary importance. In that event, the type of boring machine selected becomes the determining factor in the selection of either tool storage method.

The method giving minimum interference with the operation is then selected for design. Generally C and cantilever type boring machines lend themselves better to polar tool storage devices because the spindle is always located at the same point and the table and cross-slide motions are not hindered by the tool changing cycle.

To reduce idle machine time, it is also possible to program tool changing to take place at the same

Fig. 6. Operating sequence of wrench mechanism.



time the workpiece is repositioned. Rectangular tool changing methods are more adaptable to the H type machine. Because the spindle may be located in any given position on the bridge, the tool changer must be able to join the spindle for tool changing. With suitable electrical circuitry, a rectangularly coordinated tool changer can be effectively controlled. Time sharing of positioning the machine tool table, and tool changing, however, is not feasible in this system.

After careful study of available equipment and production requirements, a rotary tool storage and separate wrench mechanism was designed and built. General specifications for the system included the following: A vertical C-type boring machine (Fosdick) was purchased. Tool storage capacity based on average hole sizes required 30 tools to be stored, tool changing cycle to take one-half minute, and the entire system to be operated under punched card control.

The development of the tool changer was divided into two projects: the tool storage device, and the wrench mechanism.

Tool Storage Device: Requirements of the tool storage device include:

1. Thirty tools are to be stored
2. Complete selectivity and availability of each toolholder must be possible
3. Tool change time should be at least ½ minute
4. Toolholder shanks must be kept clean
5. The device must be fail safe.

Tools can be removed from the tool storage device to the insertion position without vertical motion if they are stored in a slot at the periphery of a circular plate, *Fig.* 5. Instead of being lifted out of the plate, toolholders are held by the wrench mechanism while the plate retracts radially.

Each slot represents a location for a toolholder, and relates to an angle whose vertex is in the center of the plate. All toolholder locations are thereby identified. The over-all size of the plate is determined by the number of tools to be stored and by the clearance between toolholders. This clearance is dependent upon the path of the wrenches when closing to grasp a holder.

The functions of the wrench mechanism are to:

1. Contact the toolholder at the hex nut
2. Allow the toolholder to remain in the wrench while the storage plate is moved away from the toolholder
3. Permit the spindle to contact the toolholder and draw it into the cavity of the spindle
4. Impart the required amount of torque to the toolholder in the spindle
5. Open the wrench freeing the toolholder.

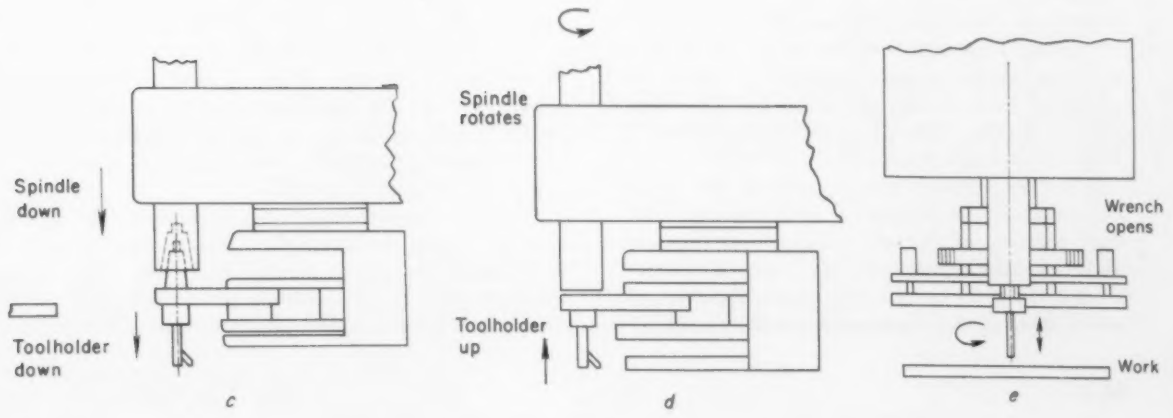
This allows the spindle and toolholder to pass between the arms of the wrench on the way down to the workpiece, *Fig.* 6.

From these functions, some design restrictions are established. The wrenches must open wide enough to clear the quill of the spindle. They must also clear adjacent toolholders when grasping the hex nut of a new toolholder.

To permit the arms of the wrench to open and close simultaneously, the base of each wrench arm terminates in a spur gear which is meshed with the other. Through suitable linkage, these arms are actuated by an air motor. The dimensions of the table and the wrenches are all closely related to the actions of the wrench linkages. Their action determines the angle to which the wrenches can be fully opened. Once this angle is known, the distance from wrench pivots to center line can be determined.

The angle at which each toolholder is located is known from the tool storage requirements. This angle, the clearance radius of the toolholder, and the full length of the wrench then determine the diameter of the tool storage table.

The Wrench Mechanism: The functions of the wrench mechanism are to grasp the toolholder, allow the toolholder to be depressed the length of



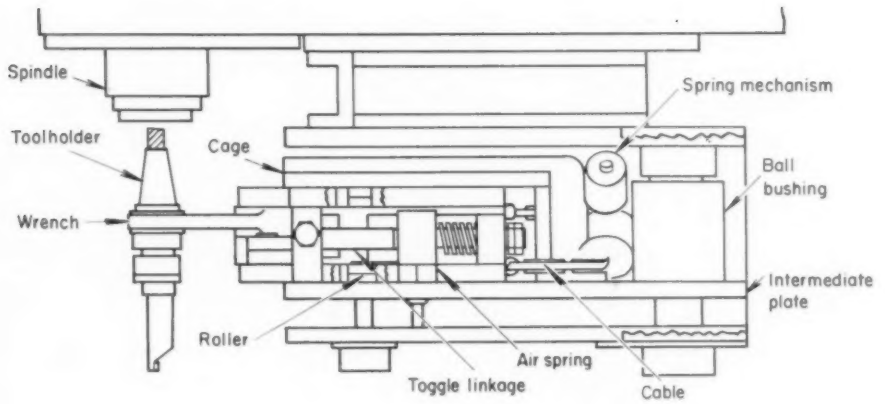


Fig. 7. Side view of wrench mechanism.

its thread, permit the spindle to draw the tool into the spindle cavity and release the toolholder when the proper torque has been reached.

The wrench mechanism is composed of three parts, *Figs.* 7 and 8: the actuating mechanism, the tightening mechanism, and the inserting mechanism. Two wrenches, each terminating in a spur gear, mesh at the wrench pivots. For the actuating mechanism, a toggle linkage is used to move and lock the wrenches. One end of the toggle linkage is fastened to the activating link of the wrench and the other end terminates in a spring mounted pivot. The spring limits the force of the toggle to the spring constant rather than some unknown force.

Advantage of the toggle linkage is that a small actuating force can be transmitted into a large locking force. The whole toggle linkage is mounted between two plates fastening together the pivots, the spring loaded end of the toggle and the mounting pad of the air cylinder. This assembly is called a cage. It is essential that the plates be rigid to prevent bending of the plates when the toggle is actuated. Any flexing of the plates results in loss of force in the toggle. The top and bottom plates of the cage have a circular slot cut into them. The center of the slot is determined by the center line of the toolholder in the spindle. A set of bearings rides in the slot. This allows the cage to revolve a fixed distance with the spindle.

When the wrenches have engaged the hex nut of the toolholder, the distance is proportionate to the time constant of the air cylinder operating the wrenches at the spindle speed of 45 rpm. Tool tightening speed of the spindle is dependent upon the reaction time of the electromechanically controlled solenoids and the response time of the air cylinder actuating the toggle. Knowing the radius of the cage circle and time constant of the control and actuating system, spindle speed is computed.

The wrenches, cage, and limit switch are mounted on an intermediate plate which is moved up and down by air springs. This function allows the toolholder to be either drawn up into or expelled by the spindle through the threading action of the toolholder. The air springs also maintain a level position for depositing or accepting the toolholder from the tool storage device. The whole mechanism is boxed in and fastened under the spindle housing, *Fig.* 9.

Operation of the mechanism is as follows: After the wrenches have closed on the toolholder, the spindle is made to engage the threaded portion of the toolholder. When the external taper on the holder contacts the internal taper of the spindle, two factors enter into tightening. One is the centrifugal force represented by the inertia force when the rotating spindle collides with the stationary mass of the cage through the toolholder. The second is the resistance offered to the spindle by the spring when the cage wants to turn in the direction of the rotation of the spindle. When a definite pull on the tightening spring has been exerted, a limit switch is actuated. This allows the jaws on the wrench to open. A minimum torque of 11 lb-ft is developed.

By varying the tension on the springs, the torque on the toolholder can be varied. Similarly, removal of the toolholder can be accomplished. The only difference is that the wrenches are not opened when the cage is displaced in the opposite direction. This

lets the tool break loose against the resistance of the wrenches. A locking device actuated at this time further prevents slippage in the wrench.

The Support Mechanism: The functions of the support mechanism are to let the tool storage device move radially toward the wrench mechanism, to be capable of vertical displacement for different heights of workpieces, and to allow rotary motion about the supporting column for maintenance of the boring machine. *Fig.* 10.

The tool storage device is carried on two parallel ground rods which are fixed to a sleeve on one end and cantilever outward. These rods allow the tool storage device to move back and forth on ball bushings. Rod ends terminate in a plate and are supported by two guy rods which help stabilize the cantilever. The sleeve is mounted on a circular column and is moved up and down by means of a rack and pinion. The motor and gear drive are integrally mounted on the sleeve, permitting rotation as well as up-and-down motion of the sleeve. Vertical alignment of the circular plate with the wrench mechanism must be held to tolerances that can be achieved economically. A tolerance of ±0.025 inch was selected and the required beam thickness calculated on this basis.

The evaluation of the over-all performance of an automatically controlled boring machine is based on actual performances and must take into consideration operating factors other than changing. Table position, selection of feeds and speeds, starting and completing the actual boring operation, loading, and unloading are all vital links in the performance of the machine tool. If it is assumed that the above-mentioned sequences are machining functions, as compared to the positioning of the table which is considered a setup function, then the difference of operating time indicates a gain or loss in performance. During 2000 hours of actual operation, a gain of 38 percent in machining time has been established by the automatically controlled boring machine over semi-automatic methods. Down time during this period has been 10 percent and of this time 1 percent has been charged against the tool changing operation. This down time of the tool changing operation was incurred mainly on the hydraulic system which moves the tool changing device towards the spindle. Contamination of the hydraulic oil with cast-iron dust has

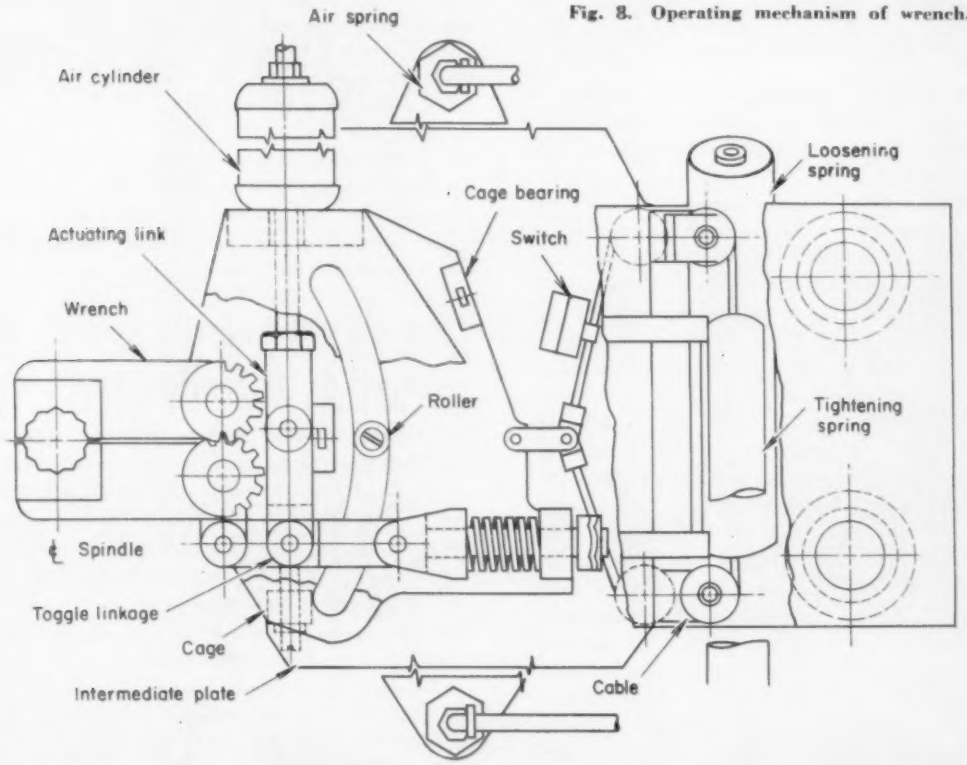


Fig. 8. Operating mechanism of wrench.

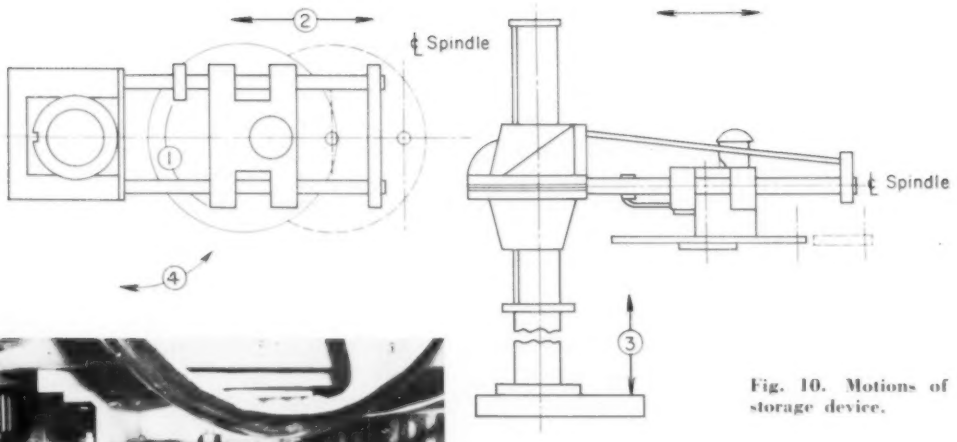


Fig. 10. Motions of tool storage device.

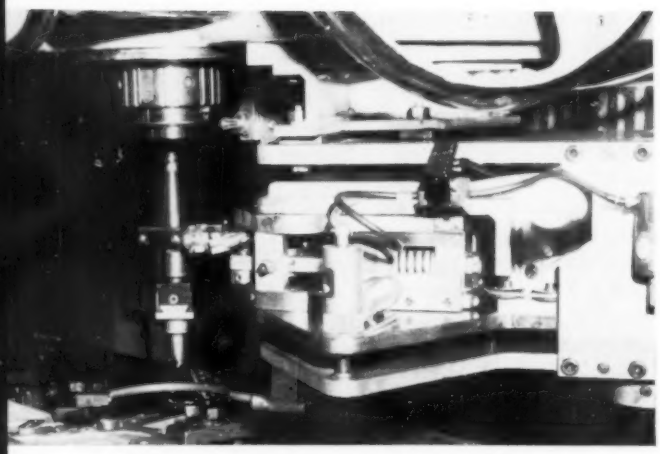


Fig. 9. Wrench mechanism in position to insert tool.

been a problem, requiring repeated cleaning of valves and solenoids. No other malfunctions attributed to the tool changing system have been encountered.

With the development of automatic tool changing in the boring process, it is possible to apply these techniques to allied operations. Drilling machines with automatic tool changing can be integrated with automatic boring machines. These machines can form machining areas controlled by automation computers. This is again another step forward to reduce the cost of manufacturing.

Complete automation of machine tools, although technically feasible, could prove economically impracticable. For example, in the study discussed, automatic loading and unloading is such a case. Because of the inherent low setup time required by numerically controlled machine tools, lot sizes are relatively small. Automatic loading devices, however, are specifically designed for a particular part.

Accuracy required in aligning the piece part with the machine tool coordinates makes flexible automatic loading a costly mechanism. This, in turn, adds to the cost of operation. The necessity of automatic tool changing can also be challenged with overautomation by this question. If tool changing had not been included in the cycle, a comparable reduction in machining time probably would not have occurred.

This assumption is supported by a recorded gain of 38 percent in machining time over previous methods when the digitally controlled production boring machine was used. For as long as the operator can set the pace of the machine cycle by intervening to change tools, the machine can only be as efficient as the operator. Reliability is lost because the selection of correct tools becomes again a human function, subject to human errors.

A difference between automatic tool changing and automatic loading is in the number of times each takes place in a given interval. Automatic tool changing may be hard to defend for parts having two bored holes. However, automatic tool changing again is practical in instances where parts have more than two tool changes per piece part.

This is justified with the following assumptions: that the operator can tend more than one machine, and that he is responsible for the quality of the product. His time is, therefore, occupied with checking parts, burring the piece prior to loading, loading, and checking occasional hole diameters during the boring cycle. This is not possible with the manually operated machine, where the operator can either work at the machine or perform his secondary duties; hence, automatic tool changing becomes more desirable. Another difference is that automatic loading must be flexible from one type of part to another. Tool changing is standard and easily adaptable to each job.

Acknowledgments

The author acknowledges the participation and contributions of the following IBM personnel in the development and construction of the tool changing device: A. W. Camp, T. J. Carlton, D. F. Delbridge, J. Krowiak, N. MacDonald, Mark Morgan.

designed for

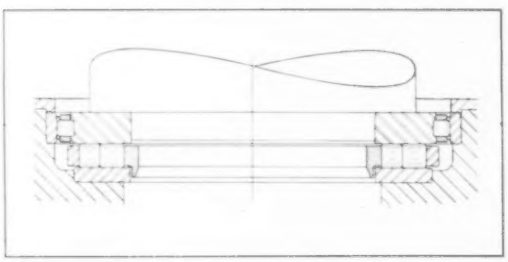
PRODUCTION

Combination Bearing Conserves Space

Designs of bearings for applications requiring thrust and radial loads has been limited to the use of two individual bearings with special mounting surfaces for each. With a dual-duty cylindrical bearing, designed by Rollway Bearing Co., the problem has been solved by combining the two bearings into one.

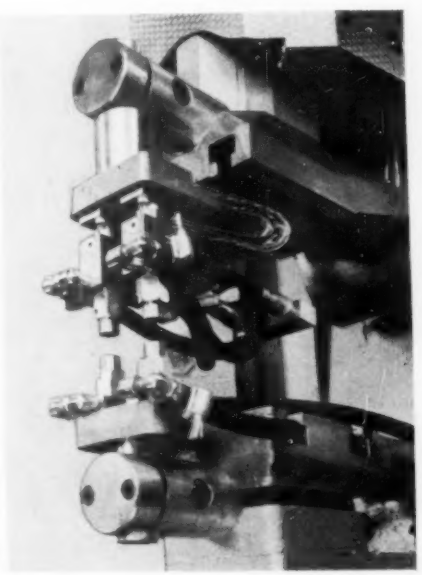
The unit consists of two roller assemblies (radial and thrust) with the flanged inner race of the radial section serving as the revolving plate of the thrust section. The outer race of the radial bearing is stationary with respect to the inner race, and is completely separable to facilitate assembly in restricted places. A step in the bore of the bearing retainer serves as a means of locating the thrust roller assembly in the bore of the stationary thrust plate. The radial portion of the bearing is located on the shaft as shown in the illustration.

An example of the load-carrying ability of this bearing can be shown by the ratings for a standard size unit with a 6⅜-inch OD and a 3½-inch bore. At 100 rpm, the radial capacity is 3150 lb and the thrust capacity is 24,600 lb; at 1750 rpm, the radial capacity is 1340 lb and the thrust capacity is 9500 lb.



Welding Pressures Equalized by Hydraulic Die Adapter

Equalized welding pressures and current on each of two or more simultaneous welds is possible with a die adapter developed by P. R. Mallory & Co. A closed hydraulic system, formed by interconnecting the die adapters, automatically maintains uniform forces on the welding tips. Minor variations in workpiece tolerances, which would tend to produce excessive force on high points and insufficient force at low points, are avoided by the built-in compensation of the hydraulic system. Changes of the electrode inserts can be made easily by loosing the adapter and inserting the new one.



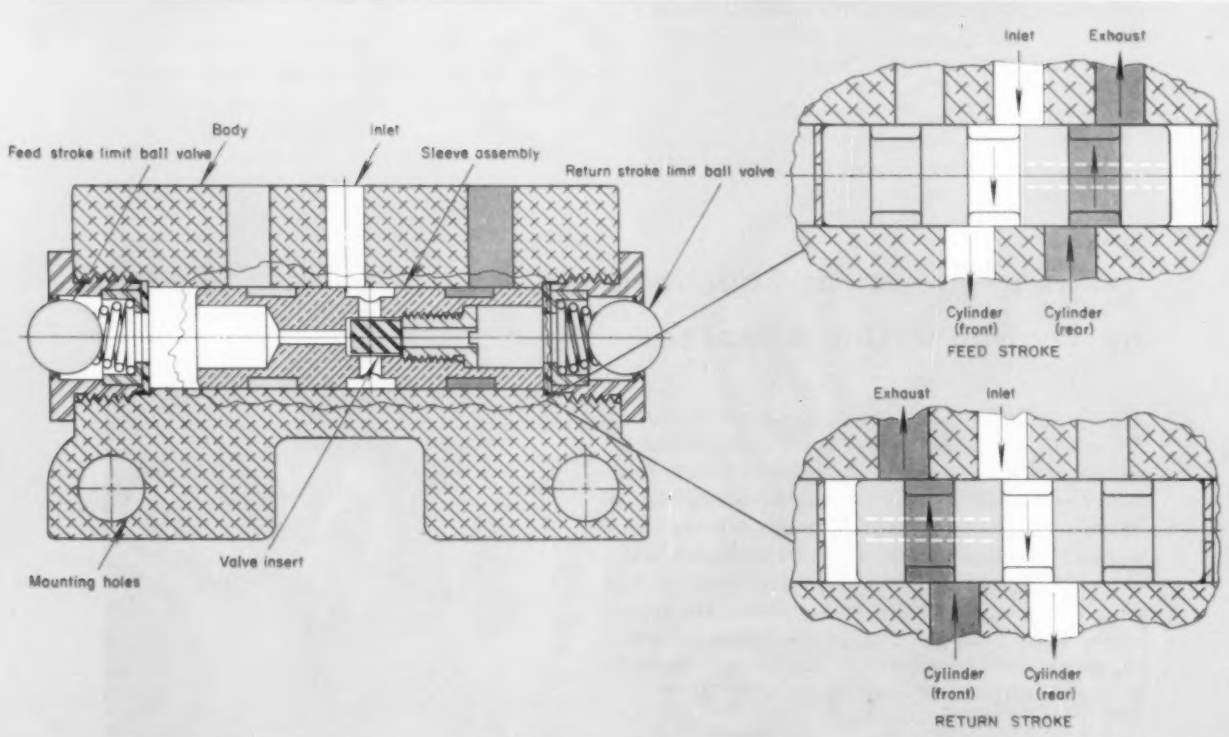
Machine Operation Controlled by All-Air System

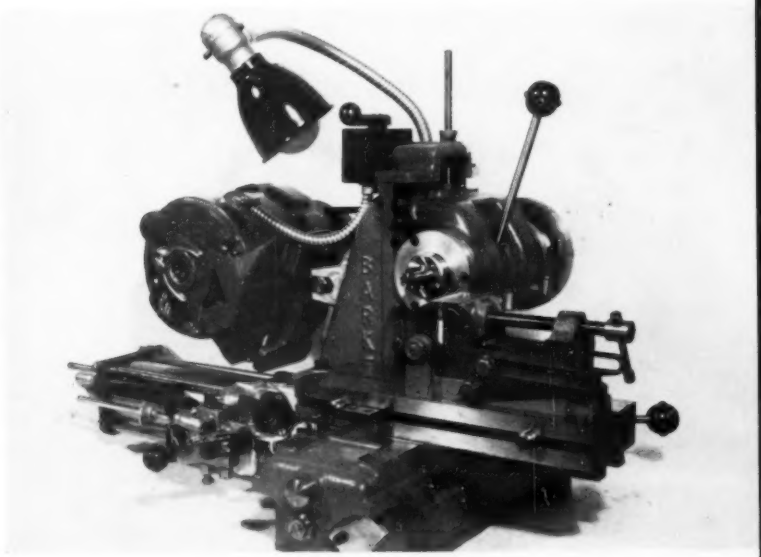
Converting standard machine tools into automatic equipment can increase productivity in small companies or on limited production equipment. With a kit produced by the Renco-Aire Div. of Cleveland Pneumatic Industries, Inc., conversion is a simple process because the control valve, cylinder and hardware are included as a package.

Heart of the packaged system is the four-way, self-sealing bleeder valve which controls air flow to the feed cylinder. Air at the inlet port is directed by spool lands to the cylinder port as determined by the spool position, shown in the illustration. Shift of the spool is accomplished by bleeder action at either end of the valve chamber. An instantaneous shift of the spool occurs when either bleeder port is opened producing a shift of the valve insert to the bleed side. This results in a differential pressure and consequently, full-line pressure shifts the spool to the bleed end.

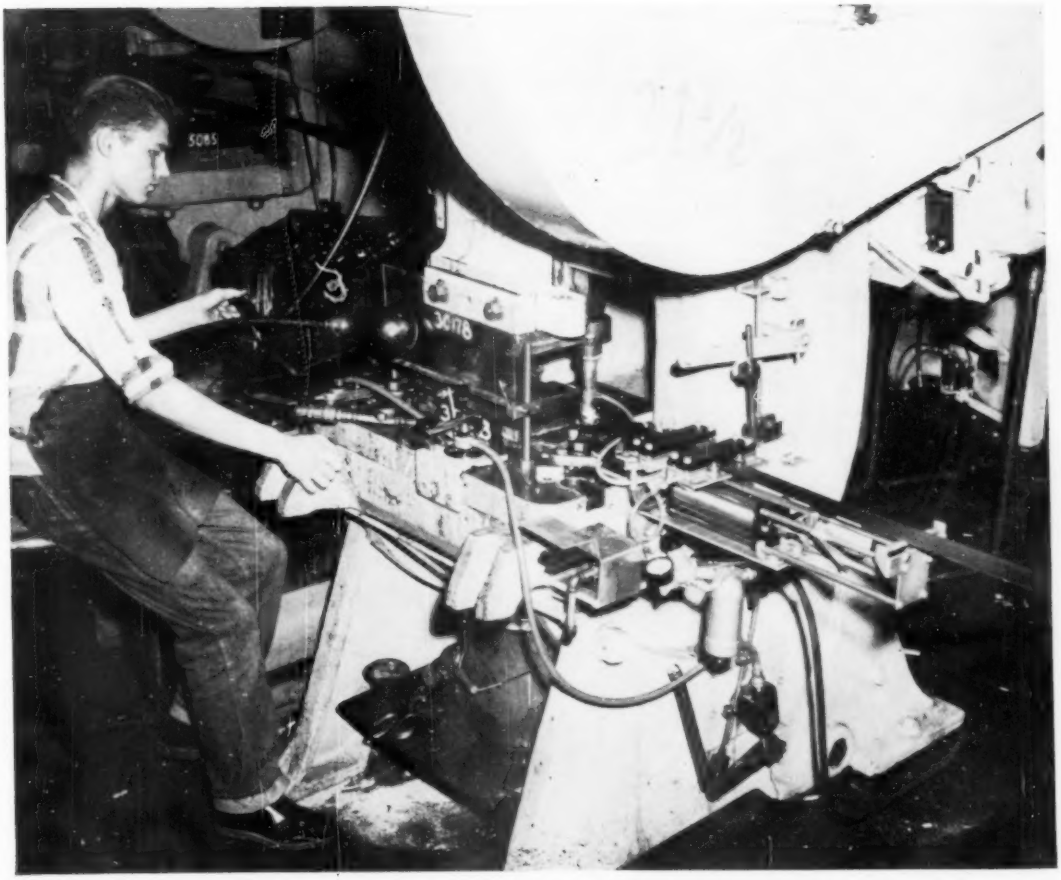
The valve is designed for high-speed operation being capable of performance at rates as high as 3000 cycles per minute. It will also operate on pressures as low as one psi. Remote actuation can be accomplished by positioning the bleeder valve through tubing, flexible or rigid, to the point where actuation is desired. Because the valve permits an all-air mechanically operated circuit, initial and maintenance costs can be reduced.

CROSS SECTION of the four-way control valve. Schematic of valve porting illustrates action of the valve during feed and return strokes





CONVERSION KIT components mounted on a small milling machine. Valve assembly is located on the left side of the machine and operation is started by bleeding air through the ball poppet valve.



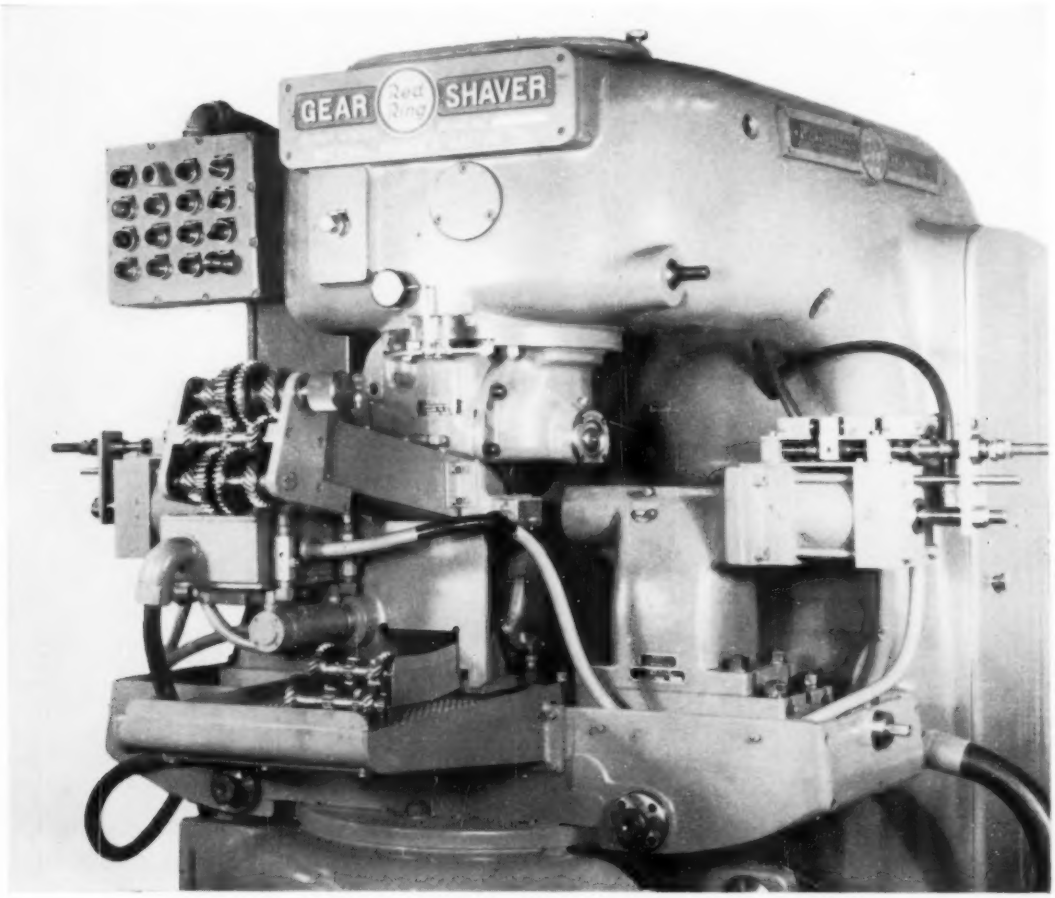
PRESS FEED APPLICATION of the conversion kit components. Sequence control of the gripper jaws is obtained by the bleeder valve unit, which also controls air flow to the feed cylinder.

Automatic Loader Provides Quick-Change Gaging

During shaving of a cluster gear, many variables affect the process. When using a standard machine equipped with an automatic loader the variables include cutter, cutter and work center distance, head and tailstock axial positioning, axial positioning of the loader and size gaging of the gear to be shaved. All the conditions can be controlled easily with the exception of the gaging. With a loader, designed by National Broach and Machine Co., provisions for quick-change size gaging are built in.

The loader is an air-powered rocker type which feeds one gear at a time from the input magazine into the shaving location. Air-operated head and tailstocks position the gears for shaving. Input size gaging functions in the loader are provided by passing the gear to be shaved between a pair of master gears before it enters the storage magazine.

To provide quick-change gaging flexibility, the upper master gears for the particular gears on the cluster being shaved are mounted on a single shaft. This upper shaft has a knurled knob which is turned manually to feed the cluster into the magazine. The lower set of gears free-wheel on the shaft and are positioned axially by spring poppets. During gage setup, the upper master is moved axially into a predetermined location and locked with a setscrew.



improving punchability of silicon steel

By **C. S. Wukusick**
and
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General Electric Co.
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Punchability of 3¼ percent silicon steel can be improved even in the heat-treated grain-oriented condition if scale is removed before punching or treatment is such to obviate scale. The punchability rating for a given material is a function of both the material properties and the punching practice.

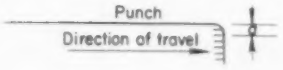
ALTHOUGH PUNCHING OPERATIONS have been performed on electrical steels for many years, little information has been available on the punching qualities of the steels. This is due primarily to the great number of variables present in a punching operation. These include the die steel, the type and capacity of the press, the material being punched and the die setup. At present, there is no accepted method of evaluating the punchability of a given steel except by making actual runs.

In 1950 Pulaski[1] set up a carefully controlled punching operation to evaluate the relative punchability of several grades of nonoriented electrical steels, 0.025 inch thick. His results demonstrated that cold-rolled strip was better than hot-rolled sheets; enameled sheets were better than bare sheets; unannealed material was better than annealed; and that sheets annealed in a reducing at-

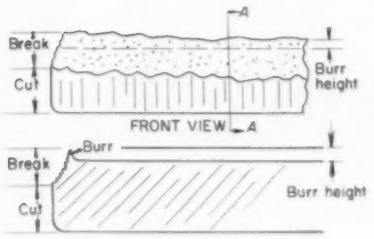
[1]References are tabulated at end of article.

Glossary of Terms

a = Amount of wear of a punch or die edge, inches



Break = Shear or cleavage fracture on the edge of a punching



CROSS SECTION AT *AA*

Burr = Ridge on the edge of a punching perpendicular to the base

Burr Height = Height of a burr measured from the base of a punching, inches

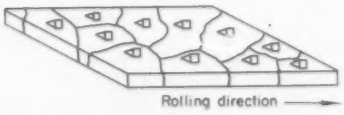
Cube-on-edge = See "Grain Oriented"

Cut = Abraded or drawn surface on the edge of a punching

Cross-Grain = 90 deg to the strip rolling direction (punching)

Fully Processed = 3¼ percent silicon steel grain oriented, annealed

Grain Oriented = 3¼ percent silicon iron with cube-on-edge orientation, a (110) plane in the plane of the strip and a [001] direction parallel to the with-grain direction



Magnetic Quality = Value of core (iron) loss, watts/lb. This expenditure of energy is due to the hysteresis and to eddy currents induced in the conducting mass

Punch Velocity = Slope of the sine curve representing the motion of the punch, ips, calculated

Punchability = Characteristic of the material that allows a reproducible number of satisfactory stampings under standard conditions

Punchability Rating = Relative measure of punchability

Semiprocessed = 3¼ percent silicon steel, as-normalized (nonoriented)

With-Grain = Parallel to the strip rolling direction.

mosphere were better than those annealed in an oxidizing atmosphere.

This discussion will deal with work on the punchability of grain-oriented 3¼ percent silicon steel. This steel has been used for several years in applications requiring punching. However, the material is not usually punched in the oriented condition (after final anneal) because of poor punchability. The punching is done after the final normalizing or decarburizing treatment where the material is fine grained and essentially nonoriented after which the punchings are annealed in a batch operation.

If the material could be punched after the final anneal, the factory processing would be greatly simplified. A short-time low-temperature stress relieving operation would replace a batch type anneal with its attendant problems such as sticking and distortion of laminations, and considerable handling. In order to distinguish between materials, the as-normalized material is termed semiprocessed and the as-fully annealed is termed fully processed. It was demonstrated in production runs that the punchability of the fully processed material was much poorer than the semiprocessed. On production presses where the number of punchings obtained between die grinds averaged about 100,000 for the semiprocessed material, the number dropped to 8,000-40,000 the fully processed material.

The objectives of this study were to:

1. Determine the cause or causes of the poor punchability of the fully processed material.
2. Improve the punchability of the fully processed material.

Test Procedure

The material used in this investigation was grain-oriented 3¼ percent silicon cold-rolled steel 0.014 inch thick (AISI M6 or M7). The type of orientation is termed cube-on-edge with a (110) plane in the plane of the strip and a [001] direction parallel to the with-grain direction. Both fully processed (coarse grain size) and semiprocessed (fine grain size) steels were studied. The samples of steel tested are summarized in TABLE 1. The code letters were used to identify the various samples.

The punch press used was a high-speed V & O No. 2 H.S., 12-ton, C-frame press, equipped with automatic feed. The speed can be varied from 150 to 400 strokes per minute. A Lempco four-post, ball-bearing die set was used.

A cross section of the die is shown in *Fig.* 1. The blank produced in this test is ¼ x ½ inch with $\frac{1}{32}$-inch radii at the corners and is punched from ⅝ inch wide strip as shown in *Fig.* 2.

Burr height from 0.001 to 0.005 inch was measured in the laboratory with a low-power binocular microscope by viewing the burrs at an angle of about 10 degrees. Burr heights less than 0.001 inch were measured with a Stereo-reticule microscope.[2]

Table 1—Silicon Steel Samples Tested

Supplier No.	Code	Test No.	Treatment*
1	A	1, 7, 8, 11, 12	Lab pickled[a]
1	B	2, 3	$MgPO_4$, fine grain[b]
1	C	4	$MgPO_4$
1	D	5	Lab pickled + MoS_2 powder[c]
1	E	6	$MgPO_4$ + MoS_2 powder
1	F	9, 10, 15	Sterling varnish[d]
1	G	13	Sterling pickled + $MgPO_4$ + enamel[e]
1	H	14	Mill pickled + $MgPO_4$
2	I	16	Mill pickled + $MgPO_4$
2	J	17	Mill pickled + $MgPO_4$ (10 deg to with-grain)
1	K	18	$MgPO_4$, (Al_2O_3 separator coating used during anneal[f])
1	L	19	Semiprocessed, annealed at 980 C, Al_2O_3 separator
1	M	20	Semiprocessed, annealed at 980 C, MgO separator

*All material is fully processed except samples L and M.
(a) Pickled in 16 percent HCl + 4 percent HF (hot)
(b) Average grain diameter = 0.020 in.
(c) MoS_2 powder applied to strip during test
(d) Inorganic material containing abrasive particles such as silicates
(e) Soft organic enamel applied in the factory
(f) Al_2O_3 powder used instead of MgO during high-temperature anneal. The powder was brushed off after anneal.

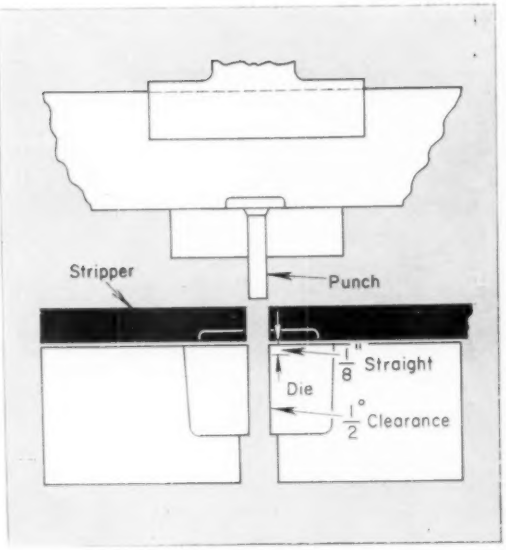


Fig. 1. Cross section of punch and die.

Three commonly used die materials were evaluated by punching the most abrasive steel; e.g., the Sterling-varnish-coated strip. The die materials evaluated were:

1. Tool steel (1.5 C, 12Cr, 0.9 Mo and 0.8 V)
2. High-speed steel (0.8 C, 6.5 W, 5 Mo, 4 Cr, 2 V)
3. Tungsten carbide (Carboloy).

The punch and die steels were heat treated to a hardness level of 60-61 R_c.

In order to determine the optimum clearance between punch and die as a function of the velocity of the punch, the following preliminary experiments were performed: Die clearance was varied from 0.0006 to 0.0024 inch in 0.003 inch increments. The speed of the press was set at 150, 200, 300 and 400 strokes per minute. The depth of penetration of the punch into the die was varied from 0.002 to 0.030 inch. In this manner the punch velocity where the punch entered the strip was varied from 2.4 to 10.5 ips.

Samples of punchings were taken at each press setting, using both semi and fully processed strip. The criterion used to determine optimum clearance was the minimum length of "cut" on the edge of a punching. The "cut" length is plotted as a function of clearance in *Figs.* 3 and 4 for the with-grain and cross-grain directions, respectively. The cut decreases to a relatively constant, level as the clearance is increased. Because the cut was constant, several tests were run at a clearance of 0.0024 inch. Examination of test punchings and the pattern of die wear indicated that the clearance should be smaller. With allowance for slight misalignment of the punch and die, the optimum clearances were considered to be about 0.002 inch cross-grain and 0.0015 inch with-grain. Subsequent tests were run at these clearances.

Depth of penetration of the punch into the die should be as small as possible according to indications in *Fig.* 4. During initial punchability tests it was found necessary to increase the depth from 0.002 to about 0.005 inch as the dies became worn. Subsequent tests were run at a depth of 0.005 inch. *Fig.* 3 shows that varying the speed of operation from 150 to 400 strokes per minute had little, if any, effect on the fracture characteristics. Punchability tests were run at 250 strokes per minute.

A chromium plating was applied to the punch in two tests. The plating was deposited electrolytically approximately 0.0005 inch thick. No lubrication was used except in a few tests where molybdenum disulfide powder or enamel was used. The phosphate coatings present on some of the steel strip may be considered as lubricants.

The surface conditions of the various samples were varied by the processing as indicated in TABLE 1. Samples were sectioned and examined at a high magnification, *Fig.* 5. This condition is representative of materials B, C, E and F in TABLE 1. During the anneal, the MgO coating reacts with the steel to form a magnesium silicate[3]. Also, a subscale of silica or silicate particles forms just under the surface. When the surface of material K was annealed under similar conditions but an Al_2O_3 separator coating was used during anneal, there was no silicate formation. This indicates that the Al_2O_3 does not react with the steel. At 980 C very little scale forms when Al_2O_3 is used as a separator. Some silicate formation occurs, however, at 980 C

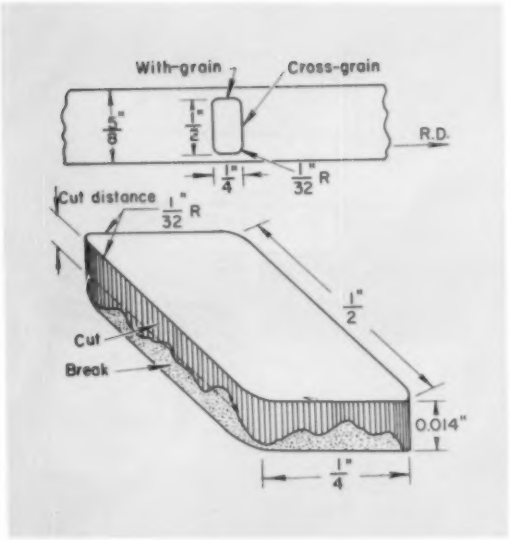


Fig. 2. Orientation and shape of punchings.

when MgO is used but the condition appears to be much less abrasive than when annealing is carried out at 1175 C.

Punchability Tests

The material to be tested was slit into $\frac{3}{8}$ inch wide strips. A quantity of one sample of strip was used as a base material. At the start of each test a few punchings were made from this material and examined to insure that starting conditions (alignment and die sharpness) were the same for all tests. The criterion used was the amounts of "cut" and "break" on the edges of the punchings.

All tests were run at 250 strokes per minute and the depth of penetration of the punch into the die was set at 0.005 inch. Sample punchings were taken after every 5,000 or 10,000 punchings. Tests were terminated when the burr height reached from 0.003 to 0.005 inch. Burr height was plotted as a function of the number of punchings. Some tests were stopped for economy reasons after long runs even though the burr height was low. In these cases the total number of punchings required to produce a 0.005 inch burr was estimated.

The results from all tests are given in TABLES 2 and 3. The code letter for material refers to the material treatment as listed in TABLE 1. Tests 1 to 8 listed in TABLE 2 were run at a die clearance of 0.0024 inch and the die steel was the 1.5 C, 12 Cr tool steel.

During punchability tests, as the dies become worn, the burr height increases as does the "cut" on the edge of a punching. *Figs.* 6 and 7 show cross-grain while *Figs.* 8 and 9 show with-grain behavior of the material as the dies wear. The "cut" measurements are more sensitive than burr height in the early stages of a test. Also, the burr height increased more rapidly when punching with-grain even though in a few tests the starting conditions in the cross-grain direction were poorer. The punch and die were inspected after each test in order to determine the wear pattern. They were then ground and inspected in preparation for the following test.

Comparison of Tests 9, 10 and 15 shows that carbide dies are far superior to steel dies in that material which runs up to about 30,000 punches per grind on steel dies will run better than one million punches per grind on carbide dies. Since carbide dies cost several times as much as steel dies, they are applicable only when a large number of punchings are to be made. For example, one investigator[4] estimated that if the total number of punchings is sufficient to wear out a steel die, then it is economically feasible to use carbide, due to decreased grinding costs.

In Tests 7 and 8, the punch was hard-chromium plated in order to determine if increased wear resistance could be obtained. However, during punching the forces acting on the edges of the punch cause the plating to spall at the edges. As a result little or no improvement was obtained.

Material Variables: Most of the material variation was accomplished by varying the surface conditions. It was possible also to obtain a small variation in grain size and orientation.

Tests 2 and 3, TABLE 2, were run on material with reduced grain size (0.020-inch diameter) and orientation (60 percent). All other tests were run

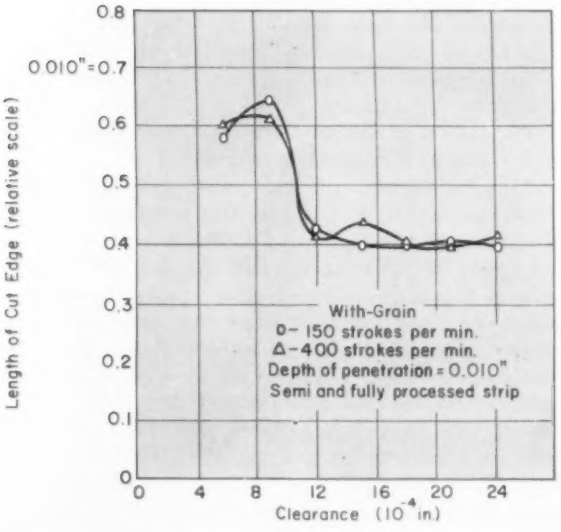


Fig. 3. Effect of clearance on cut edge when punching with-grain.

on material with larger grain size (0.10-0.25 inch) and higher orientation (80 percent). Comparison of Tests 2, 3 and 4 indicates that reduced orientation and grain size provides a little improvement. The magnetic quality decreases with decreased orientation so that significant improvements in punchability cannot be obtained in this manner without sacrificing magnetic quality.

The punchability at 10 degrees to the with-grain direction may be slightly poorer as indicated by comparison of Tests 16 and 17. However, examination of the corners of punchings from several tests indicates that the punchability is not very different at angles between the with and cross-grain directions.

Variations in surface conditions caused wide variations in punchability. The surface condition and the die material were found to be the most significant variables. The scale formed during the high-temperature anneal is abrasive and unless this scale is absent little improvement in punchability can be realized unless carbide dies are used. Removal of the scale by pickling in 16 percent HCl + 4 percent HF acid resulted in improvements from about 30,000 (Tests 2, 3, 4, 11, 12) to about 150,000 punches per grind (Tests 1, 5, 11, 12).

The effect of the abrasive scale on die wear is shown in *Fig.* 10 for Test 3. The die edge is tapered indicating that abrasion has taken place. *Fig.* 11 indicates that for cleaned material (Test 5) a radius was produced on the edges of the die. The MoS_2 used in Test 5 was not a factor because a subsequent test on abrasive material with the MoS_2 showed the same pattern of wear as in *Fig.* 10. About three times as much material must be removed in sharpening the die when abrasive material is punched. If one defined punchability in terms of the number of punchings per unit of die length, then the estimated punchability of the abrasive material must be reduced by about two-thirds in comparison with the pickled materials. TABLES 2 and 3.

Another important factor is the coating applied after final anneal. If a magnesium phosphate is applied after pickling, further improvements are obtained. For example, the material (I)used in Test 16 was mill-pickled and Mg phosphate coated. The pickling operation is costly and difficult to control. As a result, the surface condition varies widely from sample to sample. Material used in Tests 13 and 14 was also mill-pickled but the abrasive scale was not completely removed. In these tests only 50,000-75,000 punchings per grind were obtained, compared to 500,000 for well-cleaned material (Test 16).

The use of a soft enamel appears to be of some benefit on abrasive material. Compare Tests 13 and 14. The Sterling varnish-coated material is more abrasive than the Mg phosphate coated. As noted previously, this is probably due to abrasive particles such as silica which are added for insulation.

When Al_2O_3 powder is used as an annealing separator, the abrasive scale does not form, presumably because the Al_2O_3 does not react with the steel sur-

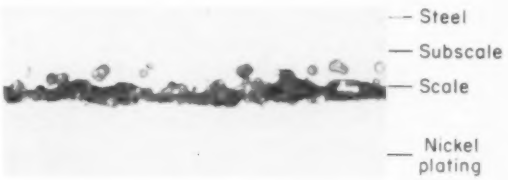


Fig. 5. Surface of material annealed at 1175 C with an MgO separator coating. 1000X.

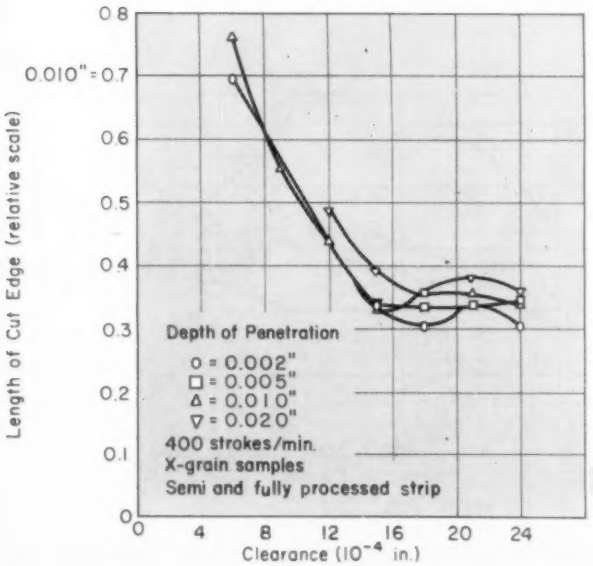


Fig. 4. Effect of clearance on cut edge when punching cross-grain at 400 strokes per minute.

Table 2—Punchability Tests*

No. of Test	Material† Code	No. of Punches	Final Burr W-Gr. (in.)	Final Burr X-Gr. (in.)	Estimated No. of Punches @ 0.005 in. Burr
1	A	137,000	0.0026	0.0018	150,000
2	B	35,000	0.0029	0.0034	40,000
3	B	35,000	0.003	0.0027	40,000
4	C	30,000	0.005	0.002	30,000
5	D	98,000	0.0026	0.0018	125,000
6	E	30,000	0.0036	0.0037	35,000
7	C‡	10,000	0.005	0.005	7,000
8	C**	27,000	0.0034	0.0015	30,000

*Die clearance = 0.0024 in. per side
Speed of press = 250 strokes per minute
Penetration of punch into die = 0.005 in.
Die steel 1.5 C, 12 Cr tool steel.
†Material described in Table 1.
‡Chrome-plated punch, 0.001 in. clearance.
**Chrome-plated punch, 0.0029 in. clearance.

face. Test 18 indicates that good punchability may be obtained for a material so processed. The important point is that no pickling is necessary. The Al_2O_3 powder was removed by brushing and the strip was then phosphate coated. Initial experiments indicate, however, that magnetic quality is impaired due to retention of sulfur in the steel. When MgO is used, the sulfur is removed. Experiments are being continued, due to the favorable punchability.

Another method of reducing the scale condition is illustrated in Tests 19 and 20. When the steel is annealed at about 1000 C, the scale condition is more favorable than at higher temperatures. At 980 C the Al_2O_3 coating appears to be slightly better than the MgO. Further improvements in punchability could probably be realized by applying a Mg-phosphate coating after anneal.

Any discussion of punchability would be incomplete without mention of mechanical properties of the work material. As shown in TABLE 4, mechanical properties vary widely with direction in the strip. Note particularly the differences in modulus of elasticity and elongation. These data demonstrate why optimum die clearances vary with direction in the strip. Shearing strength also varies with direction in the strip. The data shown in TABLE 4 are only relative, since in this type of test fixture, the results depend on the die sharpness, clearance, rate of loading and other factors. If a material is extremely brittle, it will shatter under the impact loading of the dies, so brittleness is an important factor. Results of bending tests made on several samples of steel to determine relative brittleness are shown in TABLE 4. Material which fractures after only one bend over a 0.187-inch radius is considered too brittle for punching without excessive shattering.

Correlation with Production Runs

The punchability test results can probably be considered as the upper limit as to what may be expected in a production run. There are several reasons why the production runs are much shorter than test runs. Among these are:

1. The size of a punching is usually much larger so that alignment problems are multiplied
2. The press is less rigid because capacity of the press in relation to the size of the punching is usually much less
3. The distortion and movement of the strip while punching is greater
4. The speed of operation is usually less, of the order 30 strokes per minute.

Experience has shown that three to five times as many punchings are obtained in a test as in production of large punchings. On this basis, materials which give 300,000 to 500,000 punchings per grind in a test should give 60,000 to 160,000 in production.

No adequate theory has been developed to enable

KEY

4 Fully Processed + $MgPO_4$
15 Fully Processed + Sterling varnish
16 Fully Processed + Mill Pickled + $MgPO_4$
17 Fully Processed + Mill Pickled + $MgPO_4$ (10° to with-grain)
18 Fully Processed + $MgPO_4$ (Al_2O_3 Separator coating used during anneal)
19 Semiprocessed + Al_2O_3 Separator annealed at 980 C
20 Semiprocessed + MgO Separator annealed at 980 C

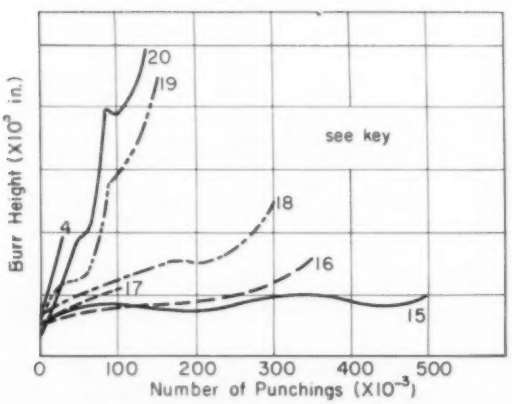


Fig. 6. Cross-grain burr height curves.

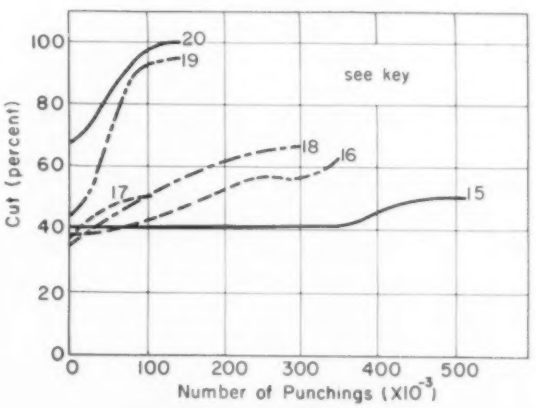


Fig. 7. Cross-grain "cut" curves.

Table 3—Punchability Tests*

No. of Test	Material† Code	Material‡ of Dies	No. of Punches	Final Burr Height W-Gr. (in.)	Final Burr Height X-Gr. (in.)	Estimated No. of Punches @ 0.005 in. Burr
9	F	b	24,000	0.0031	0.0032	30,000
10	F	a	17,000	0.0027	0.0032	25,000
11	A	b	125,000	0.0018	0.0018	170,000
12	A	a	100,000	0.0039	0.0021	120,000
13	G	b	75,000	0.0024	0.0024	100,000
14	H	b	50,000	0.0034	0.0029	75,000
15	F	c	500,000	0.0015	0.0008	1,000,000
16	I	b	350,000	0.0026	0.0016	500,000
17	J	b	100,000	0.0014	0.0012	400,000
18	K	b	300,000	0.003	0.0024	400,000
19	L	b	150,000	0.0065	0.0045	130,000
20	M	b	150,000	0.0075	0.0067	100,000

*Die clearance: With-grain = 0.0015 in. per side. Cross-grain = 0.0020 in. per side (for Test 15)
Clearance = 0.021 in. per side
Speed of press = 250 strokes per minute
Penetration of punch into die = 0.005 in.
†Material described in Table 1.
‡a = 1.5 C, 12 Cr tool steel
b = High-speed steel (W-Mo-V)
c = Tungsten carbide

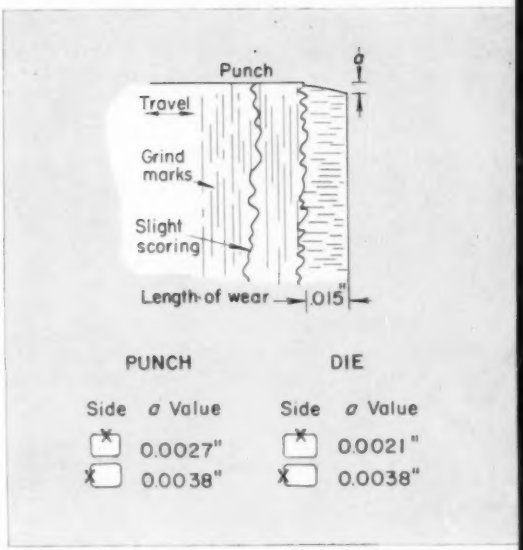


Fig. 10. Die wear Test No. 3 Material B, 35,000 punchings.

one to predict the punchability of a material. It is conceivable that an equation could be developed which would consist of several parameters which evidently have an effect on the punchability. These could be thickness, mechanical properties, composition (inherent abrasiveness), grain size and orientation, a surface condition factor, and lubrication. Such an equation would also require a term which would be constant for a given die practice. The variables involved here are no less important, among them being the die material, grinding practice, die alignment, depth of penetration of the punch into the die, speed of operation of the press, press capacity, shear angle, relief angle, etc.

The punching process is admittedly complex but *Fig.* 12 illustrates three steps occurring during punching. The sketches were drawn from measurements made on the cross sections of edges of punchings. Initial deformation occurs by drawing the steel over the edges of the punch and die. Then the edges penetrate the steel in the area labelled the "cut." The final stage is the "break" where a shear or cleavage type fracture occurs.

It is evident that the most desirable condition

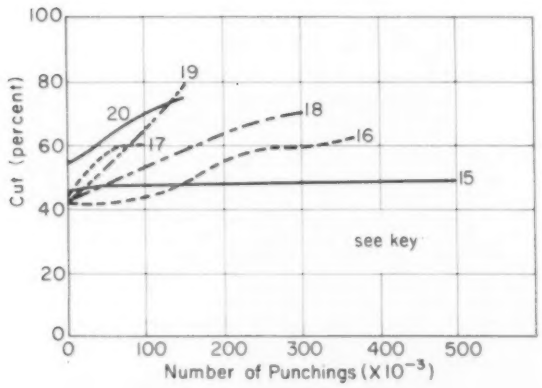


Fig. 8. With-grain "cut" curves.

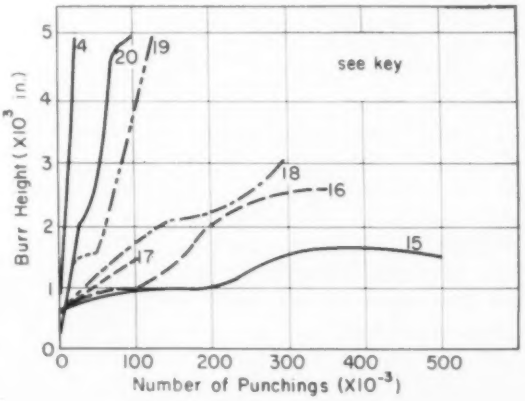


Fig. 9. With-grain burr height curves.

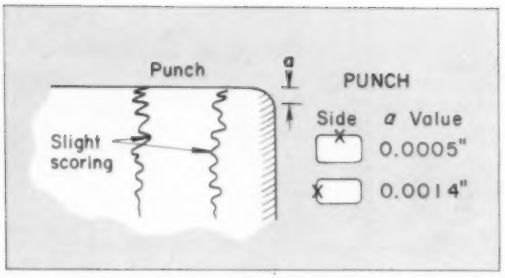


Fig. 11. Die wear Test No. 5 Material D, 98,000 punchings.

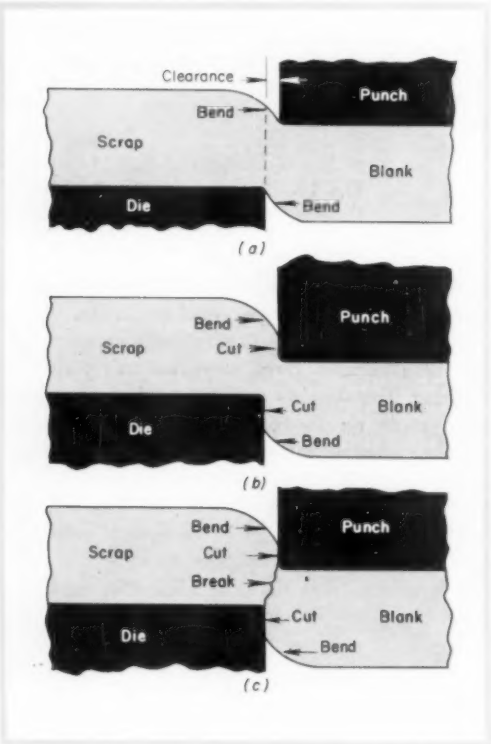


Fig. 12. The punching operation shown in three steps. Oriented strip, 0.014 inch thick. Cross-grain, 0.0024 inch clearance.

would be minimum length of "cut" edge or maximum "break" because then the contact between the die and the material, causing wear of the die, is minimized.

Theoretically it is not necessary for the punch to enter the die, according to *Fig.* 12. It would seem that considerable die wear could result from abrasion occurring between the punch and die especially if abrasive particles are present. However, it is not practical to set the punch so that it makes the punching but does not enter the die, because the punch and supporting structures are not rigid.

The following conclusions are drawn: Tungsten

Table 4—Mechanical Properties of Oriented 3¼ Percent Silicon Steel

Mechanical Property	Tensile Properties Angle from With-Grain Direction (deg) 0	90	55
Tensile strength, psi	59,000	64,000	68,000
Yield strength, 0.2 percent O.S., psi	53,000	54,000	62,000
Elastic limit, psi	41,000	42,000	54,000
Elongation in 2 inches, percent	7	33	2
Modulus of elasticity, psi x 10^{-6}	18	30	38.6
Yield strength/Tensite strength	0.90	0.845	0.91

Angle from R. D. (deg)	Shearing Strength Crystallographic Plane	Shearing Strength,* (psi)
0	(110)	86,740
35	—	71,110
55	(111)	61,930
90	(100)	67,090

Type of Steel	Bending Tests† No. of Bends to Fracture 25 deg C	10 deg C
Supplier No. 1 (Material C)	(5-31)	(4-24)
Supplier No. 2 (Material I)	(1-15)	—
Supplier No. 2 (Regular grade‡)	1	—
Supplier No. 1 (Semiprocessed)	30	—

*Average of 10 tests as measured by a double shear test fixture.
†Test consists in bending a with-grain Epstein strip over a 0.187-inch radius.
‡Not processed for punchability.

carbide dies are capable of punching oriented silicon steel even under abrasive conditions. The punchability of oriented silicon iron may be greatly improved by removing abrasive scale, preventing the formation of abrasive scale, and annealing at a temperature below which the abrasive scale forms.

The use of a solid lubricant such as enamel provides considerable improvement. However, improper die practice can mask any material improvements. The punchability rating for a given material is a function of both die (punching) practice and material condition (surface, grain size and mechanical properties).

When this article was written, the authors included information and expressed opinions believed to be correct and reliable. Because of the constant advance of technical knowledge, the widely differing conditions of possible specific application and the possibility of misapplication, any application of the contents of this article must be at the sole discretion and responsibility of the user.

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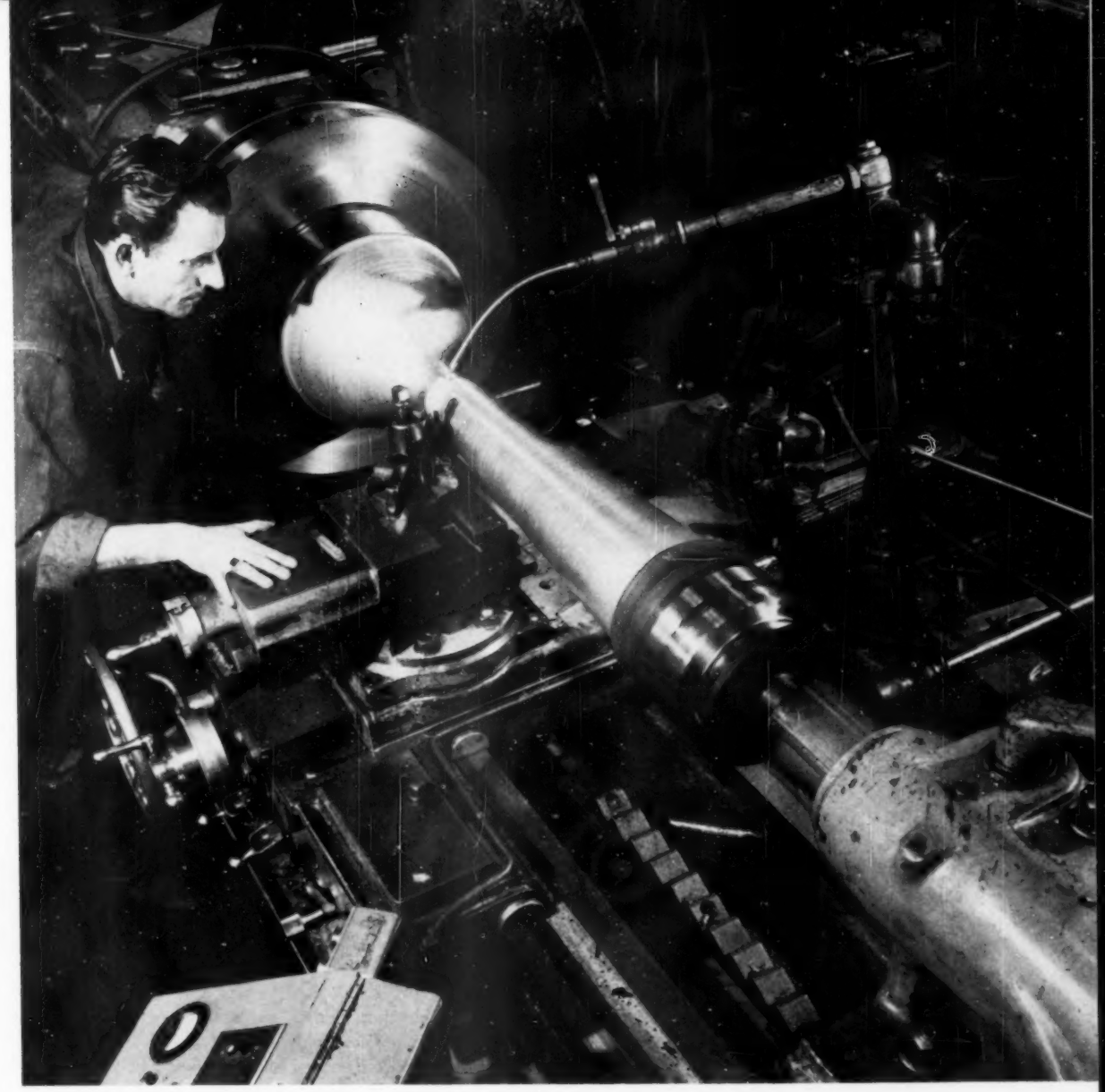
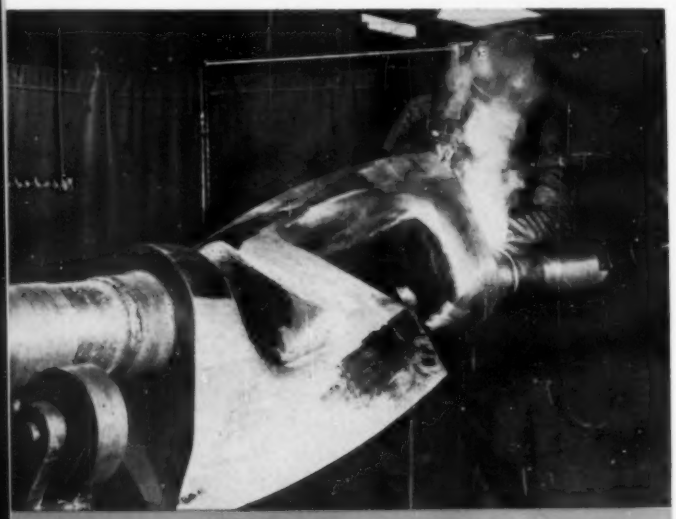
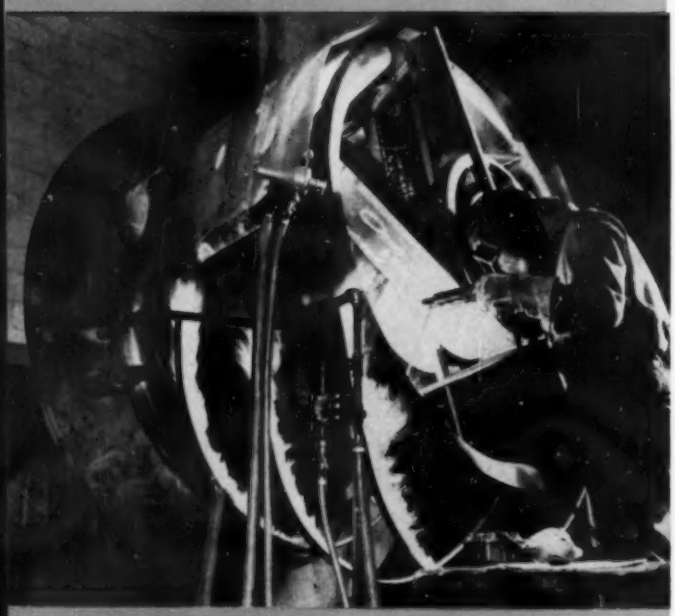


INTRICATE NOZZLE for a hypersonic wind tunnel is precision contour-machined on 36 x 192-inch Monarch lathe at R. H. Freitag Mfg. Co., Akron, Ohio. Lathe is equipped with Monarch-Keller tracer controls. Piece is contour-bored and turned to a constant wall thickness of 0.560 inch from a heat-treated stainless-steel bar. Since the nozzle is designed to handle a 5000-mph air flow, surface finish requirements are stringent. If a surface blemish did occur, the nozzle would heat to incandescence and finally melt due to air friction produced by the hypersonic flow.

TOOLS at work

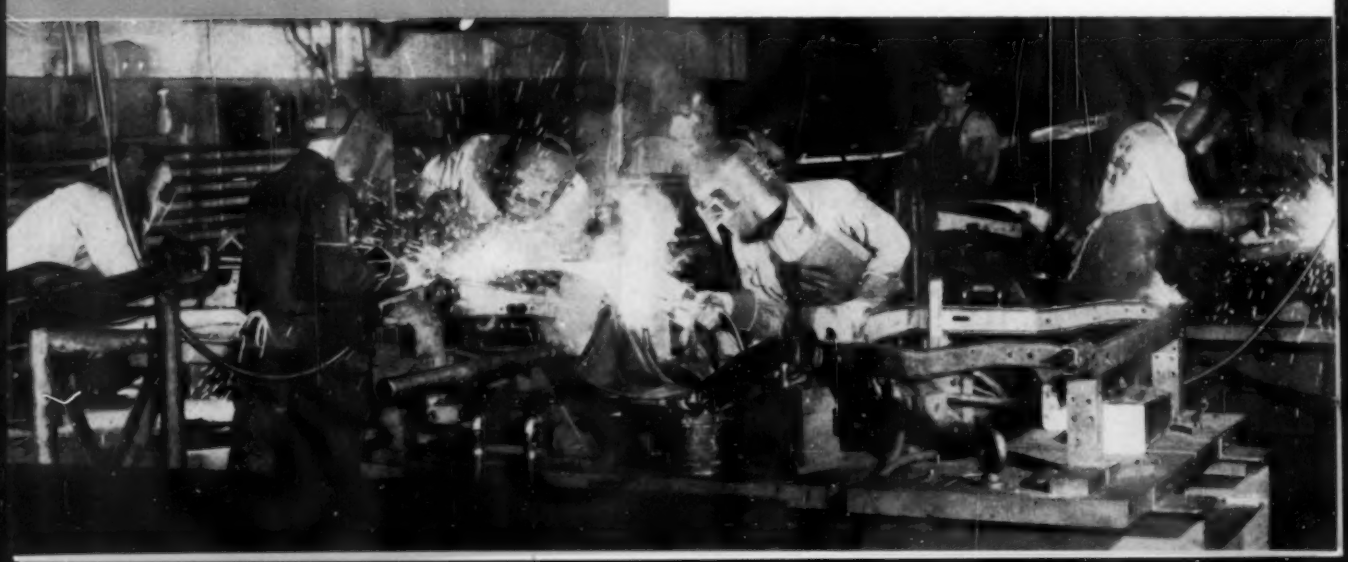


LOW-CARBON STEEL AXLES (left) are welded to a 650-pound, S-shaped, cast stainless steel mixer blade at Baker-Perkins, Inc., Saginaw, Mich. The mixer is used for mixing solid-liquid rocket and missile fuels. A positioner utilizing a lathe chuck and a variable speed drive holds and rotates the work, enabling the operator to make deep penetrating welds around the circumference of the 4-inch diameter axles. The axles are shrink fitted to the blade body prior to welding. Foot pedal arrangement enables operator to control the powered positioner as he applies the stainless-steel welding rod. About 4 hours are required to complete the work.



THREE 3-INCH THICK CHROME-MOLY STEEL HUBS (center) and radial members or vanes are welded to 60-inch diameter chrome-moly steel gas turbine cylinders at R. C. Mahon Co., Detroit. The 4850-pound cylinders are mounted on a rotating table. Since the work requires preheating, and heat is maintained constantly at 450 F during welding to avoid stress cracks, it is almost surrounded by flames. Sheet metal hoods help retain the heat as welding progresses. Rods are of the 90-16 low-hydrogen class. After welding, work is stress relieved, then finish machined, with warpage and shrinkage controlled to within $\frac{1}{16}$-inch limits.

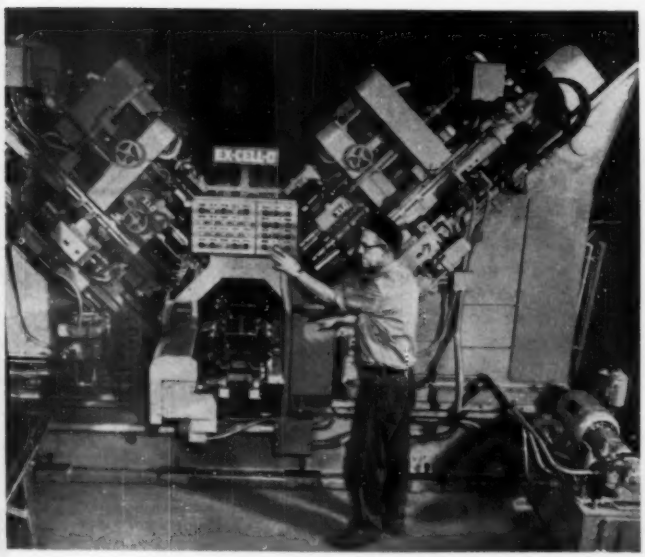
DEVELOPMENT of an atmospheric-air-cooled gun (below) has made it possible to utilize the cost-cutting potential of the CO_2 shielded-arc welding process in the production of automobile frames at Parish Pressed Steel Div. of Dana Corp. The light weight of the gun permits easy manipulation and production welding speeds of over 200 ipm when making fillet welds on mild steel frame subassemblies. Gun, control and wire-feed unit are portable. Wire is fed from 500-pound coils. Welding equipment is manufactured by Hobart Brothers Co.



AUTOMATED JIG BORER cuts milling time 50 percent on compressor disks. It is part of the new facilities for large-scale engine production at General Electric's Small Aircraft Engine Dept. Used to make blade slots, the machine can make nearly 100 slots (contour and dovetail) in two automatic operations. Previously the slots were made with a manually controlled milling machine. Built by DeVlieg Machine Co., Detroit, Mich., it will be used in the manufacture of turbine engines.

TOOLS at work

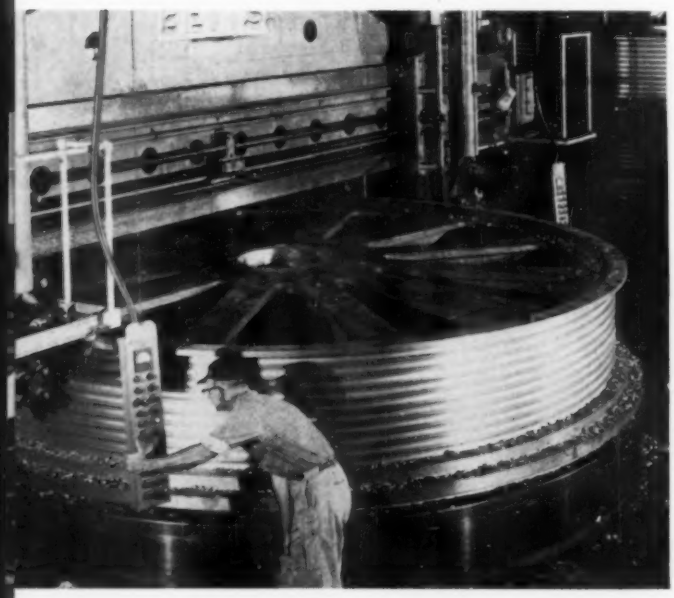
AUTOMATION has been applied to the manufacture of outboard marine motors with the development of a pallet type transfer machine for V-4 engine blocks by Ex-Cell-O Corp., Detroit, Mich. Center distances of the cylinders are close, so two blocks are partially machined in each cycle. At the roughing station, the rearward pair of cylinders of the first engine block and the forward pair of cylinders of the second block are machined simultaneously. Transferring brings the unmachined cylinders under the boring bars. Other operations are chamfering and finish boring.



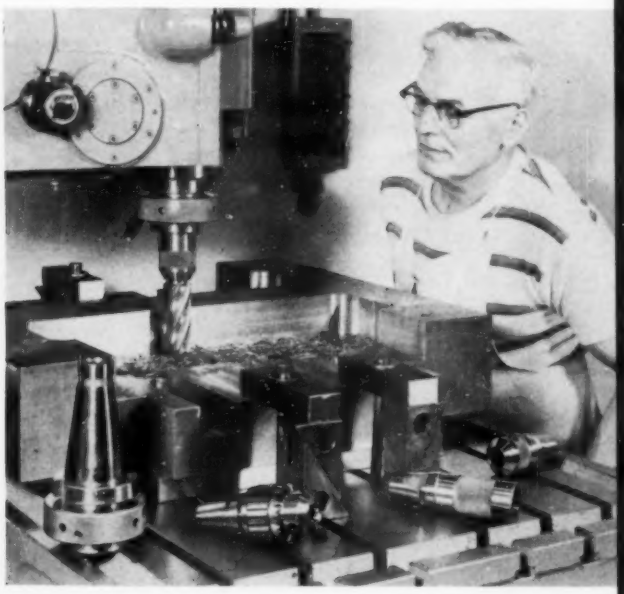
QUICK METHOD for making large quantities of brazing rings from a spool of silver alloy wire is practiced by Fenwal Inc., Ashland, Mass. To start the coil the end of the brazing wire is inserted through a hole in the mandrel shown and is secured by bending it around the circumference of the mandrel. The operator rotates the chuck a few turns by hand to obtain proper lay of the wire before starting the lathe. Upon removal from the mandrel, the coil of Easy-Flow wire (Handy & Harman) is clipped up the side with wire cutters. Several hundred rings are completed.

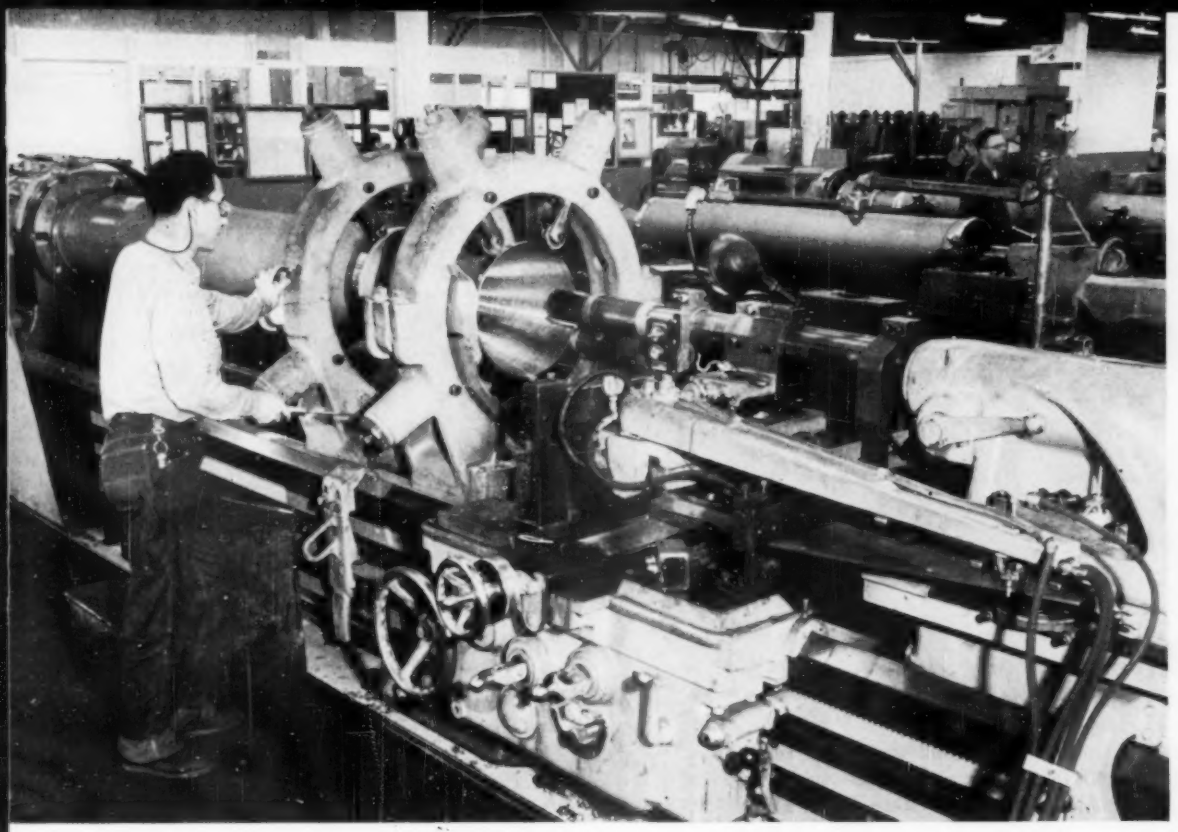
TOOLS at work

TEN GROOVES, each $1\text{-}\frac{3}{16}$ inches deep, are being machined in this 60,000-pound steel casting, one of eight sheaves for a vertical lift bridge. Cast at the Coraopolis, Pa. foundry of Blaw-Knox Co., the sheave is over 16 feet in diameter and 31 inches deep. Two grooves are rough cut at one time on this 20-foot vertical boring mill. Finishing passes are made one groove at a time with cuts from both sides. Close tolerances are maintained.



FAST TOOL CHANGES are required to keep machine down time at a minimum, especially in short-run production where changeovers are frequent. With Kwiklok holders and adapters shown, tool change time has been cut from over three minutes to a few seconds on tough milling job at Hamilton Broach & Gage Co., Detroit. The holders and adapters are made by Falcon Tool Co., Detroit. Machine is a Boko boring mill.

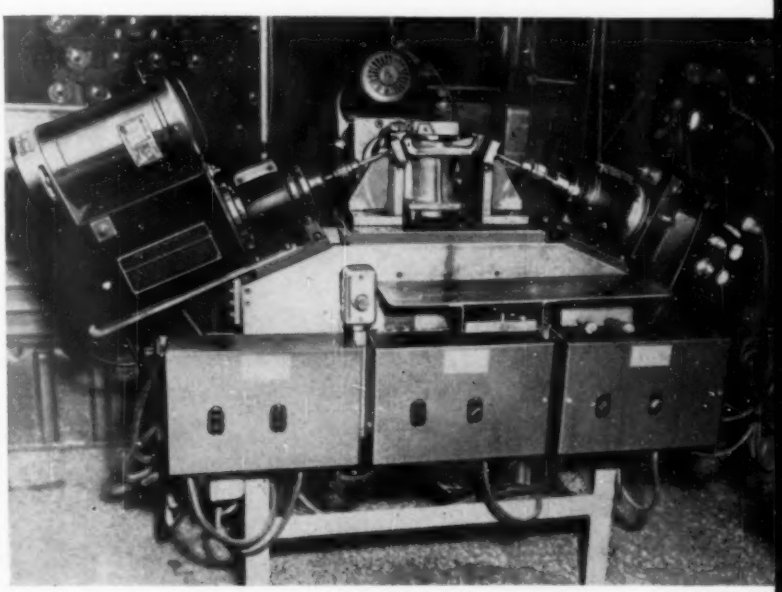




FINAL THRUST ALIGNMENT of a rocket engine case assembly for a Nike antiaircraft missile is carried out with tracer-controlled equipment at the Goodyear Aircraft Corp., plant in Akron, Ohio. The workpiece weldment—comprising a 4130 steel nozzle, tube and forward ring—must be corrected for any bore distortion caused by welding or heat-treating operations, and receive final alignment for fin attachment rings. Goodyear Aircraft performs this job with carbide tooling on a 44-inch swing Monarch heavy-duty lathe, equipped with a swiveling air-gage tracer. The swiveling tracer, combined with the machine's 204-inch bed length, permits the entire alignment job on this large piece of missile hardware to be completed in a single chucking, thus reducing setup costs.

BUILDING-BLOCK CONSTRUCTION is used in special machine at Massey-Harris-Ferguson. The part is a tractor take-off housing in two sizes. The operation is to drill three 0.3220-inch holes and then tap the same holes in both housings. Previous methods used a heavy, cumbersome tumble fixture, drilling and tapping one hole at a time. By setting up three drilling and tapping units on a bench with simple fixturing added, as shown, the three holes are first drilled, then tapped automatically. The operator merely positions and removes housings.

Bushings are removed when tapping is to be done. Taps fit into the chuck of the drilling unit. Unit is made by the Dumore Co., Racine, Wis.



Tilting Solves Piercing Problem

By H. A. Sygnator*
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Illinois Tool Works
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RECENTLY, a difficult piercing problem confronted engineers designing a die for producing an irregularly shaped flanged part, *Fig.* 1. An effective low-cost method was required to pierce an oblong hole, angular to the flange, to exact size and at the same time maintain accurate angular location without distortion.

Four approaches were considered in searching for an answer as follows:

1. Make part complete in progressive die except pierce oblong angular hole in secondary operation
2. Pierce hole prior to drawing shell in progressive die
3. Make part complete in progressive die with the use of a cam principle in piercing the oblong hole after drawing the shell
4. Make part complete in progressive die by tilting the semifinished blank out of plane for piercing oblong hole after drawing the shell and then returning it to original plane to be blanked out in the next station.

The first method was discarded because investigation of the cost of extra handling and part positioning in a secondary operation was not justified. Method two proved unsatisfactory because of distortion and lack of hole location accuracy. The third method showed possibilities in using a cam type principle. After studying the die layout, however, it became evident that original die cost and die maintenance cost would be too expensive.

The last method proved to be a simpler and more direct approach. It has been successful in producing steel parts 0.035 inches thick, 13/16 inch wide, 1 inch long and 3/8-inch draw, at a rate of 150 strokes per minute, trouble free, on a 45-ton press.

In development of the blank, the results obtained for an irregular draw took basically the same outline of the flange of the part. This shape allowed

*Senior member ASTE Fox River Valley chapter.

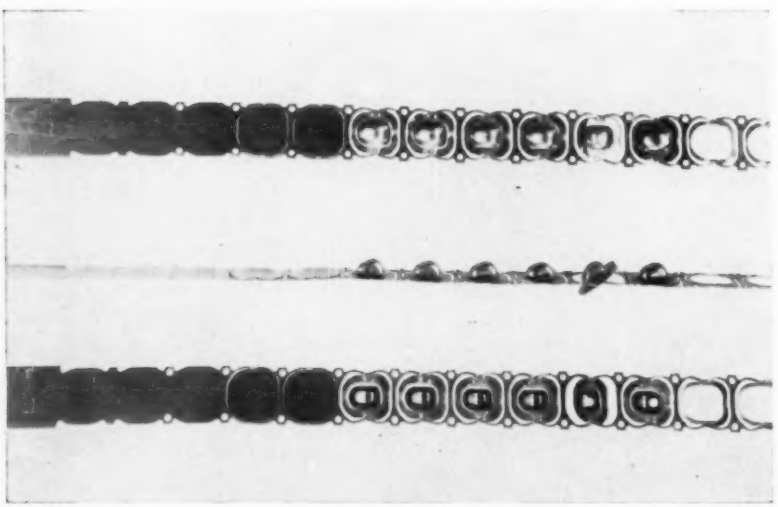

Fig. 1. Die strip showing how part is tilted for piercing oblong hole. By tilting, angular accuracy is maintained and distortion avoided.

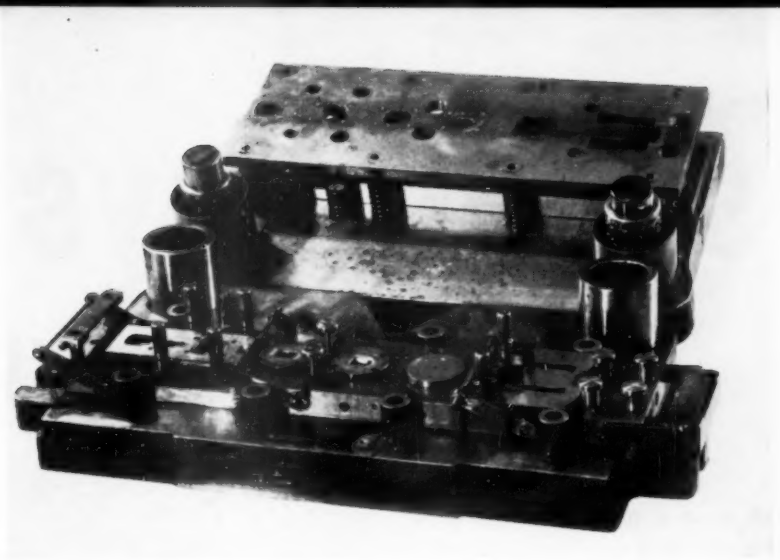

Fig. 2. Cross-section of die. After tilting part is returned to flat position and blanked out.

the strip to be designed with flexible webbing that allowed the part to draw in and be twisted, yet be rigid enough to maintain spacing and carry the part through the die.

Piercing the oblong hole is shown in *Fig.* 2 and is accomplished as follows: The locating former is assembled in a secondary spring stripper plate guided by leader pins within the die. *Fig.* 3, which also supports and strips the blank from the oblong piercing punch.

The timing is devised so that the main stripper holds the strip in place while the locating former tilts the blank, then the locating former holds the blank while the oblong punch pierces the hole.

During the up-stroke of the press the oblong punch is stripped first by the locating former and the rest of the stripping is completed by the main stripper plate. The blank is then returned to its flat, or original, position and blanked out in the cutoff station.

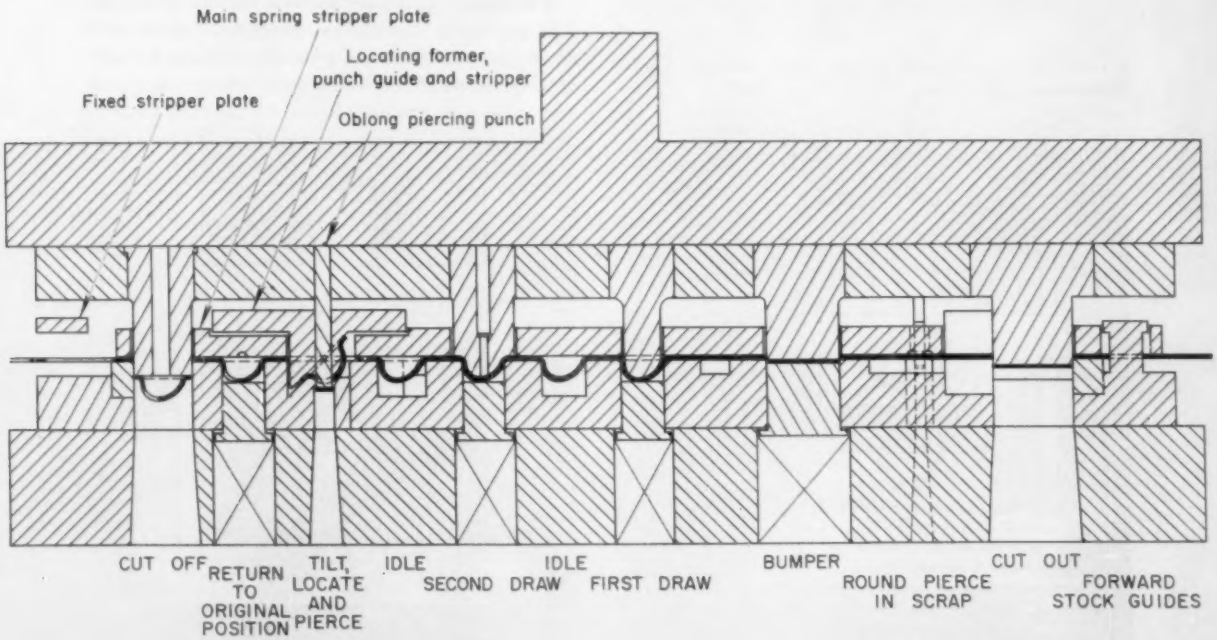

Fig. 3. Die used for piercing angular hole. Main stripper holds strip while locating former tilts blank.

superalloys formed with explosives

By Paul J. Wolf
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Air Materiel Command
Wright-Patterson AFB, Ohio

High-strength alloys and other materials used in aircraft and missile production have physical properties which make many common production methods unusable. Explosive forming of metals offers a new approach to problems met when working high-strength alloys, as well as providing cost savings when applied to ordinary materials.

From a talk presented at the Sixth Annual Tool Engineers Conference, Purdue University.

SHAPING METAL BY EXPLOSIVES is not basically new. Explosive forming for production, however, is relatively recent. The list of present and possible applications is growing daily. The success of explosive forming in accomplishing metal shaping is attributed to the high velocities at which metal movement takes place. These velocities are usually over 200 fps and sometimes as high as 15,000 fps. At these high rates of loading the pattern of metal behavior is drastically different from that observed during near static loading such as obtained when using drop hammers, brakes or hydropresses. Each metal or alloy seems to have its own critical forming velocity. If the rate of metal flow is too high, the material may shatter. A reduction in the order of 50 to 100 fps from the critical velocity may result in good plastic flow characteristics.

Forming: Explosive forming is accomplished by a shock wave, *Fig.* 1, gas pressure, *Fig.* 2, or a combination of the two. Sometimes the gas pressure acts indirectly through a liquid such as oil, *Fig.* 3,

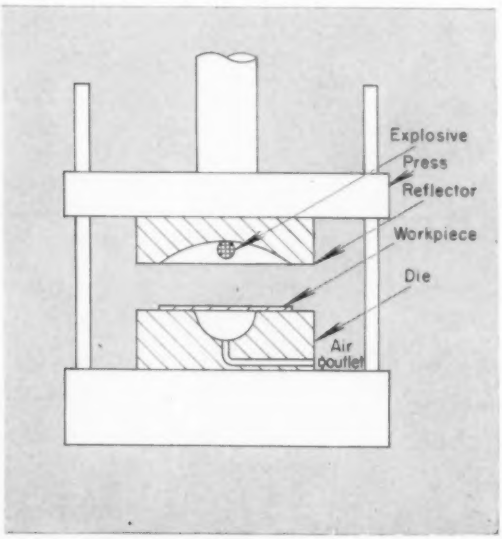


Fig. 1. Use of shock wave forming to produce a reflector. No workpiece containment is necessary.

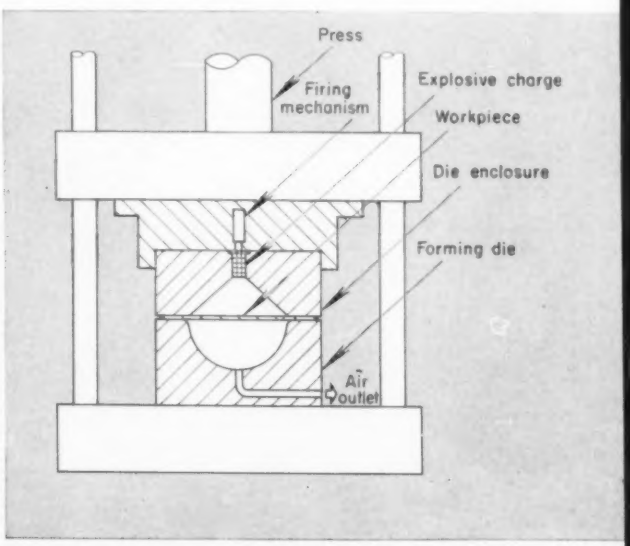


Fig. 2. Forming by means of gas pressure. Here containment is necessary and dies are held closed.

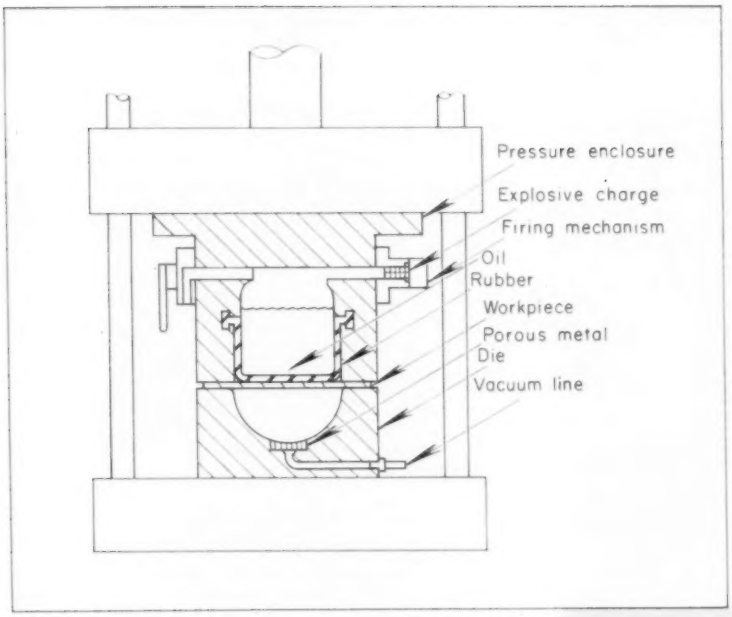


Fig. 3. Oil is used to transmit energy of expanding gases in some forming operations.

Fig. 4. Gases can actuate a piston to increase impact of a conventional drop hammer.

or to drive a piston, *Fig.* 4. Materials formed to date include molybdenum, magthorium, titanium, heat-resistant stainless steel and five percent chrome tool steels in both annealed and heat-treated condition. Forming has been accomplished on thin stainless-steel sheets, 0.005 inch thick and steel plate up to 1⅞ inches thick.

Solid and liquid propellants, powders and high explosives are used depending on the application. The explosive may be compacted or mixed with other compounds or inert materials. It may be in the form of bars, tubes, tape, cord, sheet or pellets. In sheet form the minimum thickness to insure propagation of the explosion seems to be ⅛ inch. Where

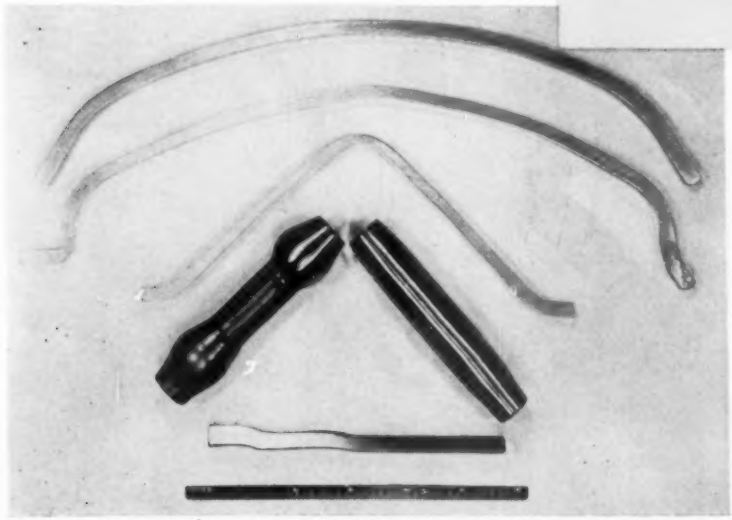


Fig. 5. Typical parts and cross-sections made by explosive forming. Tube to right of center, cross-section immediately above it and top cross-section were formed without dies of any kind—neither male nor female.

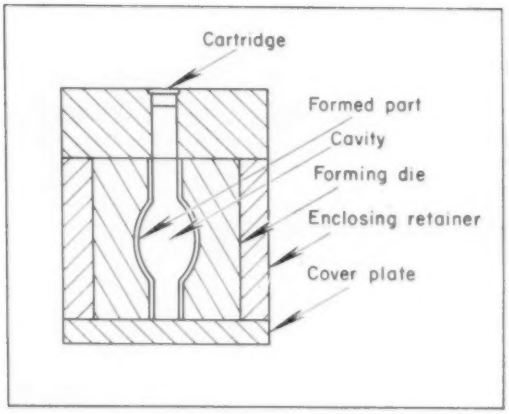


Fig. 6. Bulge forming with direct expansion of gases.

this thickness provides excessive pressures, formed plastic fillers are added to reduce explosive strength. *Fig.* 5 illustrates typical parts made by explosive forming.

Bulge Forming: Bulge forming is accomplished by methods similar to those described for forming. The energy may be imparted to the metal by either shock wave, gas expansion, *Fig.* 6, or through a liquid, *Fig.* 7.

A reduction to 0.13 from 1.66 man hours per unit was realized in one case where explosive forming in a clamping press replaced a drop hammer and weld method. Forming drop-hammer halves, welding and two sizing operations were formerly required to produce a part. The part is now bulge formed in one step with explosives. Intermediate steps such as interstage annealing, pickling, weld planishing, rough trimming and deburring are now unnecessary. Tooling cost for explosive forming was only $1650 as against $8765 for conventional methods.

Swaging: Explosive forming is used to attach lead terminals to wire cable by swaging. Required strength was obtained by this method since testing showed the joint to fail outside the swage. In this case the explosive forces the metal inward to conform to the contour of the cable.

Forging: The example of swaging described led to experimental work on forging by means of explosives. The impression formed by the wire cable was not too different from ribs or gear teeth, indicating forging might be possible.

To test the feasibility of forging a stainless-steel tube was slipped over a scrap plug gage, wrapped with explosive and fired, *Fig.* 8. A larger ring was formed from brass in the same manner and is shown also in *Fig.* 8. Although the results were unsatisfactory from the standpoint of defects in the metal, sufficient metal was moved to forge the teeth. All the

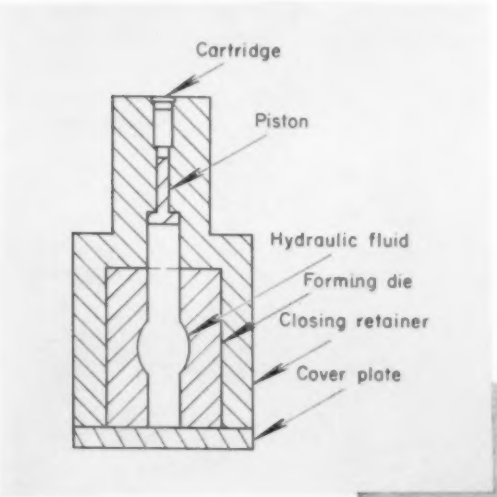


Fig. 7. Bulge forming using cartridge and exerting pressure on a piston which forms part with hydraulic fluid.

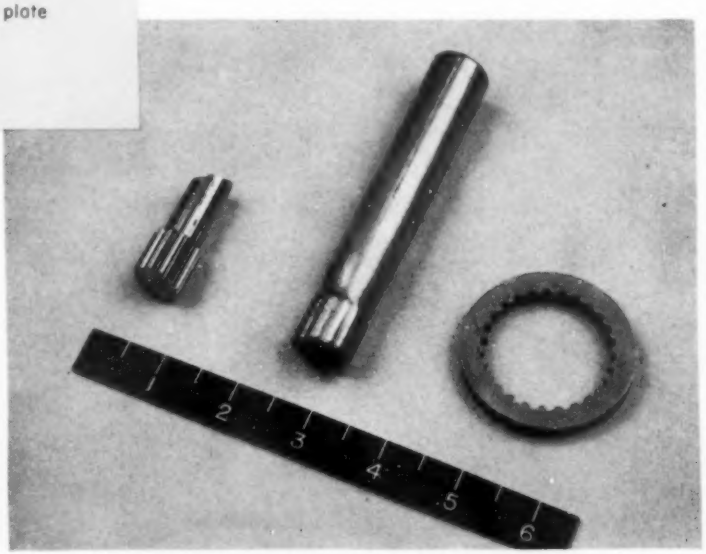


Fig. 8. Forging with explosives. Stainless-steel tube in the center was slipped over the scrap gage at left and explosive forged. Ring on right was formed from brass in a similar manner.

work was done cold which may be one of the principal benefits of this method. Further research is now under way to explore commercial possibilities.

Extrusion: Another application in experimental stages is explosive extrusion. Accidental extrusions precipitated the belief that explosive extrusion could be commercially exploited. Two methods are being considered for study: an indirect method using a ram, *Fig.* 9, and a direct method of gas expansion, *Fig.* 10.

Use of a ram is limited by pressures the ram itself will withstand. Direct gas expansion imposes no such limitation and may be the only way sufficient pressure can be generated for extrusion.

Success in explosive extrusion will result in reduced capital equipment costs and decrease extrusion time. Interest in lowered extrusion time is stimulated by a major problem extant in high-temperature conventional equipment: die erosion.

One major problem in devising an explosive extrusion process is stopping the extrusion after it has passed through the die. The extruded product will be a slender column traveling at high speed. Decelerating this column without collapsing it may be the biggest obstacle in perfecting the process.

Cutting and Flattening: Cutting billets for forging and extrusion operations is an expensive and time-consuming process, especially when billets used by some presses are 24 to 26 inches in diameter. A chipless means of cutting billets is economically attractive. It is reported that a four-inch diameter, 36-inch round bar of 4340 steel was explosively cut into two 18-inch lengths. This was accomplished by the interaction of shock waves, set up by explosives placed at either end of the billet. The cut fell within $\frac{3}{8}$ inch of the desired location and the cut surface within $\frac{1}{8}$ inch true.

Another possible area of application for explo-

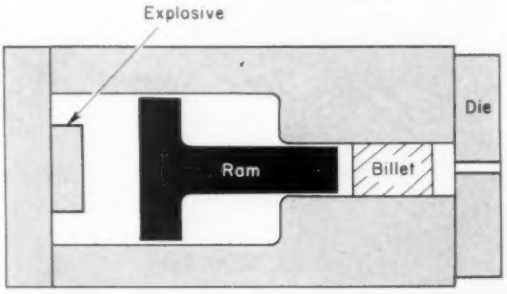


Fig. 9. Proposed method of metal extrusion using explosives. This method has possible limitations due to material strength of the ram.

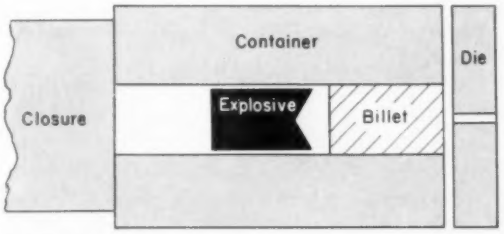
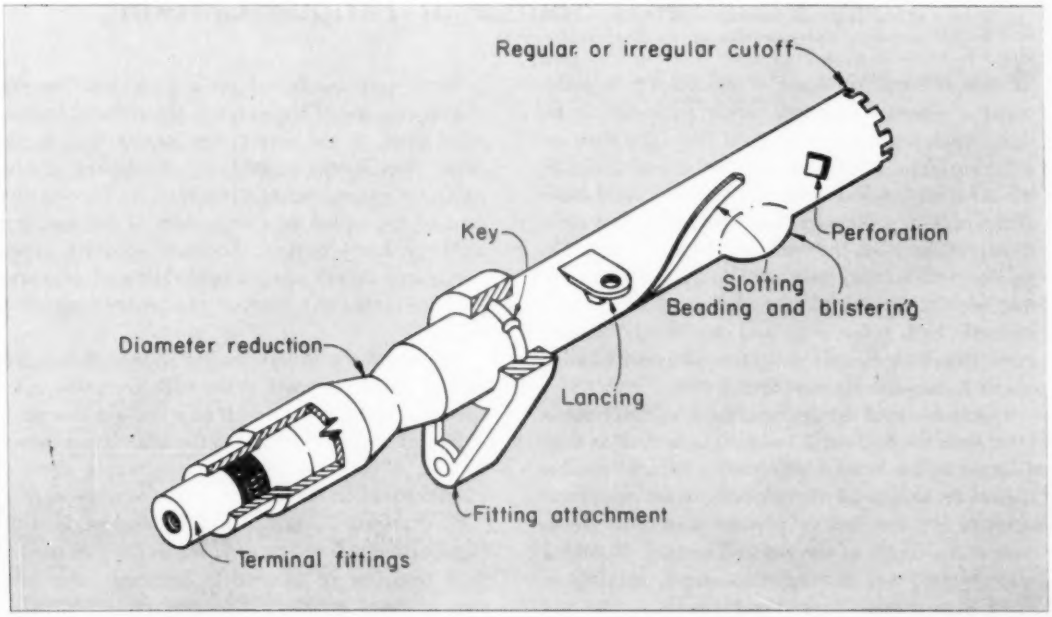


Fig. 10. Probable method metal extrusion using explosives. Direct gas pressure is considered the best way to generate force required.

Fig. 11. Many different applications for explosive forming are illustrated in this composite drawing of a theoretical part.



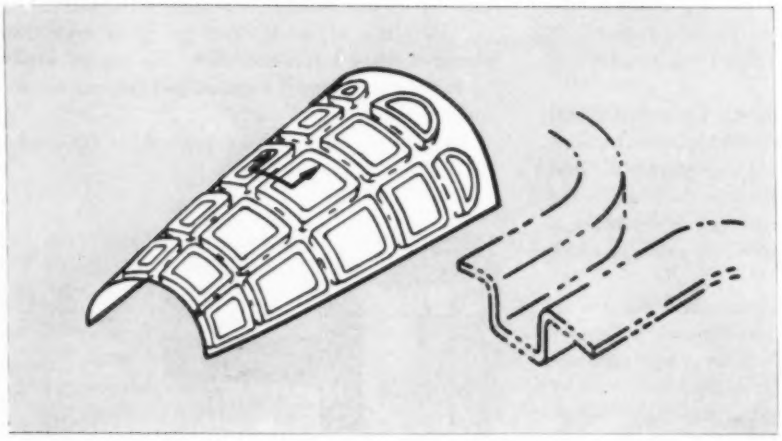


Fig. 12. Splice-free aircraft stiffeners can be formed in one operation. Parts such as these frequently require complicated drop-hammer tools where difficulty is encountered developing draft for part removal.

sives is that of sheet flattening. Thin close-tolerance steel sheet suitable for aircraft use in widths of over 10 feet is now available. Conventional flattening equipment cannot handle these widths. A project is presently under way to explore sheet flattening possibilities.

The limitations of explosive forming are not yet known. It seems, however that, whatever the limitations are, they will not be as restrictive as conventional forming processes. Press-bed size, for instance, need not be a limiting factor and the same is true of press daylight.

Metal spring back seems to be virtually eliminated in explosive forming. From a tooling point of view alone explosive forming is worthy of investigation. Since forming takes place over an extremely short period, stresses are momentary; consequently, dies and support equipment are reduced to barest essentials. This simplicity results in considerable savings of capital outlay.

Many different operations are possible with explosive forming as shown in *Fig.* 11. Some are extremely complicated to produce on conventional equipment, *Fig.* 12. In others, intermediate operations are eliminated or reduced. In all forming, possibilities are handsome indeed, and further development will possibly produce a new concept of forming gaining new freedom for design engineers.

Study Penetrates Source of Fatigue Cracking

TESTS at National Bureau of Standards have punctured a common assumption that resistance to fatigue crack initiation is lower at the edges than on a flat surface. This conclusion has grown from observation in bending tests that fatigue cracks start at the edge of a plate or sheet specimen. However, in experiments for the National Advisory Committee for Aeronautics, NBS used a type of specimen that permitted a direct comparison of the fatigue strengths both at the edges and on a nearly flat surface. Results indicated that preponderance of edge cracks is caused by stress pattern.

Specimens used in the bending tests were made of ¼-inch thick plate, 7 inches long and from 2 to 3 inches wide. Four cuts formed a reduced section toward the middle of the specimen, while two broad surfaces were milled to provide maximum thickness at the center of the reduced section. Rounded notches were cut into adjacent edges, varying in depth according to desired width.

Tests were conducted on a plate bending machine. Because of the shape of the reduced section, axial stress in the center was greater than at the edge; thus it was possible to obtain any desired value for edge-to-center stress ratio by varying contour of the milled area and width of the specimen at the reduced section. Location of crack origin then could reveal relative probability of edge and nonedge cracks as a function of edge-to-center stress ratio.

Results of the experimenting showed that reduction of fatigue strength at the edge decreases as the specimen width decreases. It now appears that probability of fatigue cracking at the edge is not caused by lack of restraint, but by strengthening effect of biaxial stress on the surface away from the edge.

By changing the radius and included angle at the edges of the reduced section, the techniques used in these tests can be adapted to investigate the influence of other geometrical factors.

numerical control or tracer control?

By Fred W. Burdett
G & L and Hypro Div.
Giddings & Lewis Machine Tool Co.
Fond du Lac, Wis.

With the demand for higher efficiency, progressive companies are investigating —and buying—fully automatic machine controls. Both tracer and numerical controls have proved their worth in production. The author reviews several successful applications of these controls and outlines some of the factors that are decisive when considering which type of control to install.

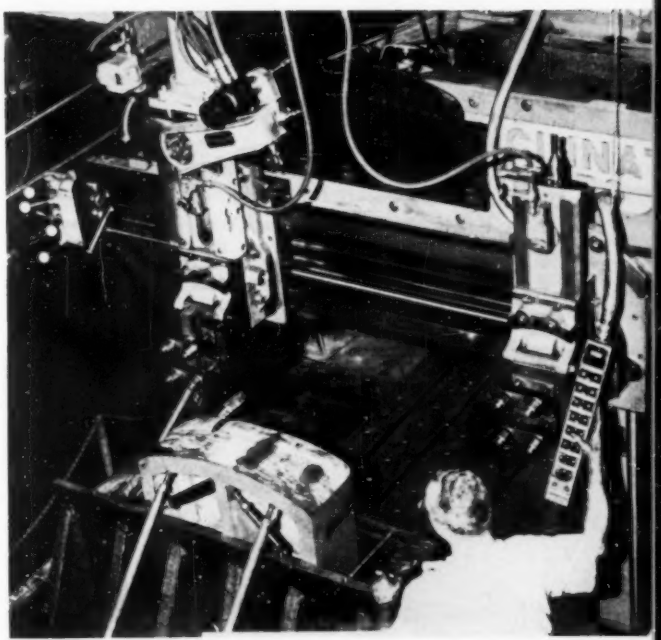


Fig. 1. Single-dimension hydraulic tracer unit on a planer with the profile template mounted on the cross rail. Position of the tool is controlled by the relationship between the stylus and template as the crosshead feeds across the rail.

BOTH TRACER CONTROLS AND NUMERICAL CONTROLS greatly increase the speed and accuracy of machining operations. In tracer control, machine movements are guided by a stylus that follows the contours of a model or template. In numerical control, machine movements are guided by means of instructions stored on tape or punched cards. Each type of system has advantages and disadvantages for specific applications.

Tracer Controls

Applications of tracer controls vary from simple machines used to produce duplicate lock keys to the complex three-dimensional tracing systems found on some large die sinking machines. The templates or cam bars must have greater accuracy than desired in the workpiece, since all tracer systems introduce some errors from the machine slides, the tracing mechanism or a combination of both. As the complexity of the workpiece increases and the number of dimensions being controlled increase, the cost of the templates and control system likewise increase.

Tracer systems are available with single-dimension, two-dimension, two-out-of-three or two-plus-one controls. The control medium can be electronic, mechanical or hydraulic. Selection of the type of control system depends to a large extent upon the accuracy required in the workpiece. As a general rule, electronic tracing systems are the most accurate.

Tracing systems have been successfully applied to many different types of machines. A hydraulic

Based on a talk presented at the Sixth Annual Tool Engineers Conference, Purdue Univ., Lafayette, Ind.

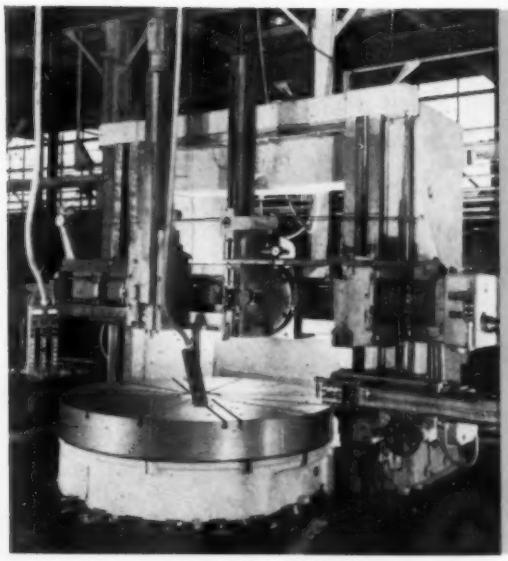


Fig. 2. Vertical boring and turning mill controlled by an electronic two-dimension tracer. The depth of the ram and the movement of the saddle across the rail are positioned by the system.

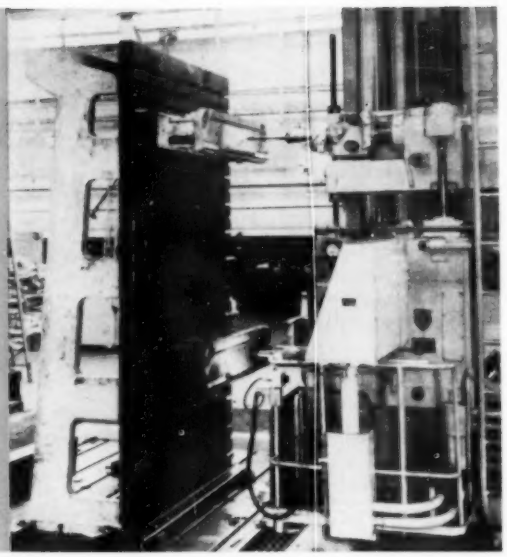


Fig. 3. Control on this horizontal boring mill is obtained by a two-plus-one dimension electronic tracer. Models are mounted above the workpiece and the follower stylus positions the cutter during contouring.

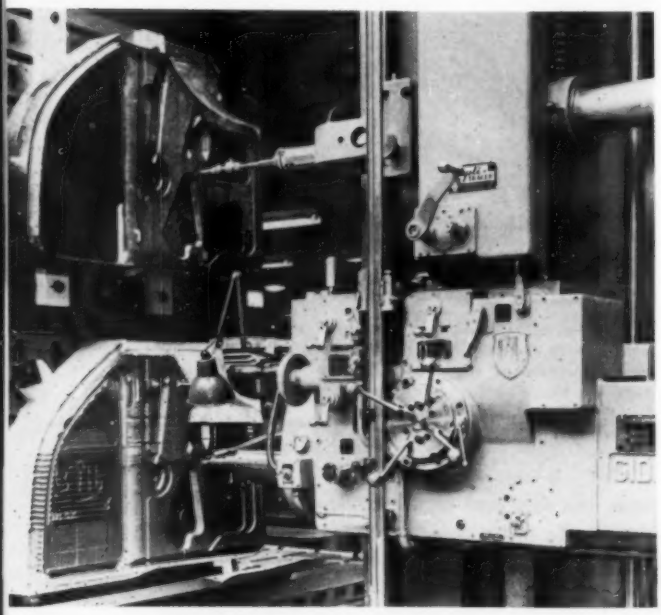


Fig. 4. Selective two-out-of-three-dimension electronic tracing system mounted on a horizontal boring mill. The workpiece being machined is mounted below the model. Cutter position is determined by the location of the stylus on the model.

single-dimension tracer applied to a planer is shown in *Fig.* 1. The profile template which controls the depth of the slide as the machine head feeds across the rail can be seen above the rail. In this type of application, it is necessary to have a hydraulic cylinder long enough to control the full range of travel on the slide.

An electronic two-dimension tracer has been applied to a vertical boring and turning mill, *Fig.* 2. Movements controlled in this case are the saddle (across the rail) and the depth of the ram.

A two-plus-one dimension electronic tracer, controls a horizontal boring mill, *Fig.* 3. The tracer stylus, in contact with the model, is shown at the top of the photograph, and below is the tool spindle. In this operation, only the depth motion of the spindle is controlled.

In the next system, *Fig.* 4, a horizontal boring mill is equipped with selective two-out-of-three dimension electronic tracing. Here, the movement of the table on the saddle, movement of the saddle on the bed, and the up-and-down movement of the head on the column are simultaneously controlled.

Cost of these systems ranges from approximately $5000 for the simple single-dimension hydraulic unit to $60,000 or more for multidimension electronic systems. These costs are nearly in direct proportion to the amount of accuracy and reliability desired. Limitations of the tracer systems involve such factors as allowing extra template mounting area (as in the case of the horizontal boring mills) and storage of templates when not in use.

In general, operations on a template-controlled machine are less and less economical as the complexity of the workpiece increases. The more

elaborate template requirements plus the problem of aligning templates with each other and with the workpiece increase the cost on the complex workpieces when over-all costs are considered.

Numerical Control

These difficulties are eliminated with numerical control systems. A numerically controlled machine can be defined as any machine whose movements or operations are controlled from information stored in some remote intelligence system. There are really two types of numerically controlled machine tools: discrete positioning and continuous path systems. Discrete positioning systems have digital inputs in the form of punched tape, cards or from the operator "dialing in" the desired coordinates on a machine control unit. Essentially, the purpose of a discrete positioning system is movement of the spindle from one position to another, similar to a jig borer type operation. In this system, the interest is only in the final location of the spindle with respect to the previous location rather than the path the spindle takes to get from one location to another.

The second type of numerical control system controls the path of a cutter continuously throughout a given cycle. Input for the system may be furnished by magnetic tape, punched plastic tape or punched cards.

The major application of the continuous path control has been a result of the Air Materiel Command's machine modernization program. AMC ordered a group of tape-controlled skin milling machines and horizontal profilers for major aircraft plants. This program is now well under way and many of the machines have been delivered and are in operation. Without exception, aircraft builders are enthusiastic about the results obtained with tape-controlled machines.

One of the horizontal spindle profilers ordered by AMC is shown in *Fig.* 5. This machine is equipped with a continuous path control system and a high-speed spindle motor. It is intended for profile machining of non-ferrous aircraft parts. Size of the workholding area is 48 by 168 inches and the spindle motor is 20/40 hp with speed selection of either 1800 or 3600 rpm.

Another of the AMC machines, *Fig.* 6, is a 96 by 144-inch planer type skin milling machine. Again, it is equipped with a continuous path control system capable of controlling five motions simultaneously.

A different style of horizontal profiler, shown in *Fig.* 7, has five motions available to a single cutter. All motions can be simultaneously controlled from commands on magnetic tape. Work area is 48 by 168 inches and the machine uses a high-speed spindle for nonferrous work.

An interesting application of continuous path control outside the aircraft industry is at the Gray Tool Co. of Houston, Texas. The company has purchased a vertical boring and turning mill equipped with a system to control the path of the cutting tool. Gray Tool Co. intends to program a group of short delivery valve bodies known as "christmas trees" in the oil industry and maintain a stock of the programmed tapes. The workpieces are all machined from the same casting. With a stock of steel castings and a supply of magnetic tapes, Gray will be able to make immediate delivery of the particular product ordered, without having to maintain an extensive finished stock inventory.

It is difficult to be specific about the costs of

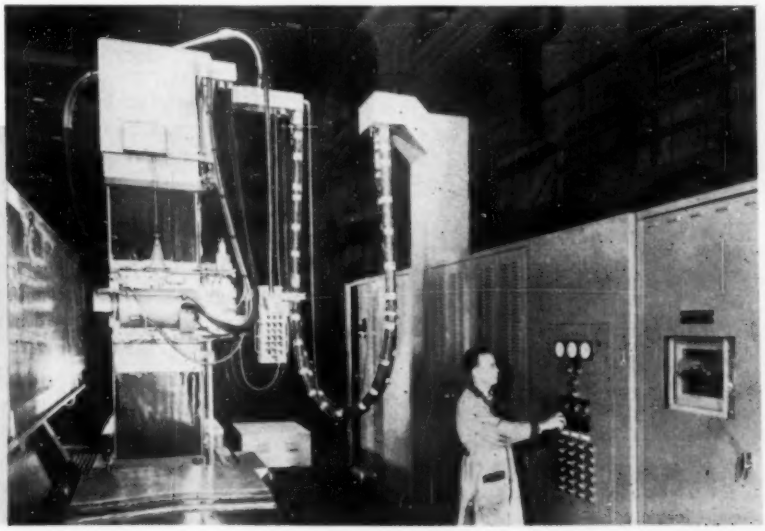


Fig. 5. Numerically controlled, variable-axis airframe profile milling machine built for the Air Materiel Command. Depth control of the cutter plus 360-degree controls are available on the machine.

continuous path control systems. Each application varies greatly depending upon just how many motions are to be controlled and the type of input data available for the system.

Accuracy is a vital subject in the numerical control field. All of the control systems available have a least count of 0.0005 inch or less. This least count refers to the smallest programmable increment of distance. Results obtained on the machine are always somewhat greater than the least count depending upon workpiece deflection, tooling deflection, machine back-lash and various other factors. The main area of accuracy on the numerically controlled machine tools is in the field of repeatability. That is, once a tape is made and a part produced, the first part will be identical with the second part in all respects. At Giddings & Lewis, approximately 200 horizontal stabilizer skins for the North American F-100 Super Saber have been produced on a tape-controlled skin mill. Repeatability is demonstrated in the relief groove made when parting skins from the surrounding scrap. A $\frac{3}{8}$-inch-diameter router bit was used to part the skins from the scrap and its groove in the vacuum chuck was not appreciably widened throughout the entire run.

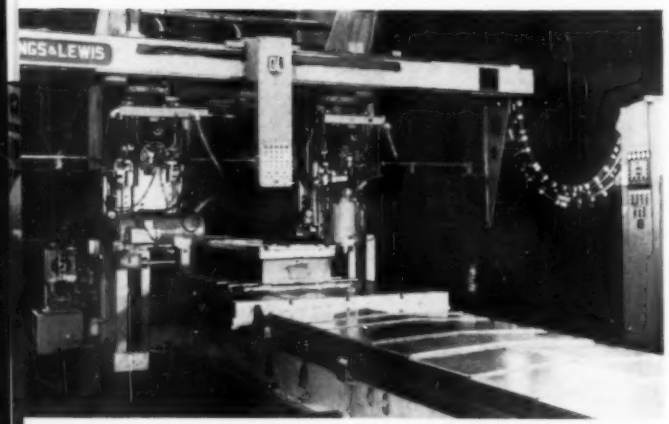


Fig. 6. Planer type skin-milling machine equipped with a continuous path control system capable of determining positions for five motions.

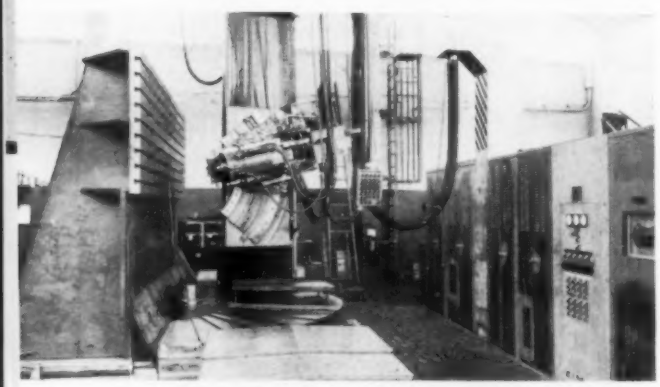


Fig. 7. Horizontal profiler with five motions controlled on a single cutter. Commands for the high-speed spindle are obtained from a magnetic tape.

Making Control Tapes

What goes into making a control tape for continuous path machining operation? After the engineering department has issued the part drawings, a program engineer makes a conventional method study describing the tool path, the desired feed rates, sequence of cuts and holding fixtures. This information is entered on a program sheet and the data is prepared for a general purpose computer. Input data runs through the computer with the number of passes dictated by the available computer routine. Output may consist of punched cards containing a completely calculated tool path including adjustment for cutter offset. The output cards of the computer are then run through a piece of equipment that puts the information on punched paper tape. This punched paper tape becomes the input for a "director." The director reads the information, line for line, storing the data in magnetic core memory units. When enough data has been stored for a complete time command, it is then recorded on 14-channel magnetic tape. The magnetic tape is taken to the machine tool and mounted on a tape transport unit for playback at the machine to control its movement. Thus, a cycle has been completed from part drawings to finished workpiece. It should be noted that various checking functions are accomplished throughout this programming procedure and every effort is made to eliminate errors.

The last consideration is the conversion of existing equipment to tape control. It is difficult to determine a cost for this work without taking each machine as an individual case. With numerical control, the necessity to have infinitely variable feed rates on all of the drives together with minimum backlash and a very low coefficient of friction is especially important. These special considerations necessarily have to be incorporated in a machine that is to be modified to obtain the ultimate benefit as far as accuracy and reliability are concerned. When converting, the equipment manufacturer prefers to have the machine returned to his plant to apply technical experience to the job.

There are areas of work where both control systems, that is, tracer and numerical control have economic application. In the areas where the tooling is quite simple and the cuts fairly simple, the best solution is usually tracer control. However, when the complexity of the workpiece increases and the template problems increase along with it, it appears that numerical control offers the best solution.

Drilling Holes for Tapping

TESTS SHOW that an increase in thread over 60 percent does not increase the thread strength in a tapped hole. For the vast majority of tapped holes, a minor diameter providing 55 to 65 percent thread is adequate. As the percentage of thread that the tap cuts is increased, the tapping torque is greatly increased. Sometimes this causes unsatisfactorily tapped holes and tap breakage and consequently high costs. Accordingly, it is desirable to use the lowest percentage of thread consistent with adequate strength, or the largest tap drill that is allowed by specifications.

There are two principal reasons why tapping torque increases as the minor diameter decreases. As thread height increases, the width of chip and the amount of material removed increases rapidly. On a basic thread form a 50 percent thread height represents the removal of only 31.25 percent of the basic thread area, while an increase to 75 percent thread height increases the area to be removed to 60.9 percent or practically double the first amount.

The second cause of torque increase is that, except in the case of spiral point or spiral flute taps, when a tap enters a drilled hole it starts cutting chips which will usually remain in the flutes as the tap advances. If stringy chips result, they roll over and over between the minor diameter of the hole and the bottom of the flutes, resulting in considerable friction. As the drilled hole becomes smaller, the amount of chips becomes so great that friction may take as much power as the actual cutting. In addition to causing friction, curling chips can score and tear the thread resulting in rough and oversize holes. This is especially true of the Coarse Thread series in sizes ½ inch and smaller.

Taps are conspicuously different from all other cutting tools in that their nature allows little variation in operating conditions. The feed per revolution is fixed by the lead or pitch of the tap. The rate of metal removal per tooth is thus governed by the effective chamfer length, the rpm, and the minor diameter of the product. In addition, the application of cutting fluid is difficult, the chips cannot always be removed from the cutting zone and the cross-sectional area of the tap is often small compared to the load imposed. Since the freedom of choice as to relief, rake and shear angles is frequently limited, and the tap must usually stop and reverse in the cut, every reasonable precaution should be taken to favor the tap. The proper care and usage of drills with equipment in good condition is of utmost importance in production of satisfactory holes for tapping.

In most materials a drill can be expected to cut oversize. Since a drill is primarily a roughing tool, deviations in the size of drilled holes are to be expected, even under ideal operating conditions. When close control over hole size is required, such as for large tap diameters and some fine pitches, reaming is generally recommended.

The accompanying table shows the percentage of thread that would normally be obtained in actual drilling operations based on test data compiled by Metal Cutting Tool Institute.

Data from "Standards and Dimensions for Taps and Dies," published by Metal Cutting Tool Institute.

Percentage of Full Thread Produced in Tapped Holes

Tap	Tap Drill	Decimal Equiv. of Tap Drill	Probable Hole Size	Percentage of Thread
0-80	56	0.0465	0.0480	74
	3/64	0.0469	0.0484	71
1-64	54	0.0550	0.0565	81
	53	0.0595	0.0610	59
1-72	53	0.0595	0.0610	67
	1/16	0.0625	0.0640	50
2-56	51	0.0670	0.0687	74
	50	0.0700	0.0717	62
	49	0.0730	0.0747	49
2-64	50	0.0700	0.0717	70
	49	0.0730	0.0747	56
3-48	48	0.0760	0.0779	78
	5/64	0.0781	0.0800	70
	47	0.0785	0.0804	69
	46	0.0810	0.0829	60
	45	0.0820	0.0839	56
3-56	46	0.0810	0.0829	69
	45	0.0820	0.0839	65
	44	0.0860	0.0879	48
4-40	44	0.0860	0.0880	74
	43	0.0890	0.0910	65
	42	0.0935	0.0955	51
	3/32	0.0938	0.0958	50
4-48	42	0.0935	0.0955	61
	3/32	0.0938	0.0958	60
	41	0.0960	0.0980	52
5-40	40	0.0980	0.1003	76
	39	0.0995	0.1018	71
	38	0.1015	0.1038	65
	37	0.1040	0.1063	58
5-44	38	0.1015	0.1038	72
	37	0.1040	0.1063	63
	36	0.1065	0.1088	55
6-32	37	0.1040	0.1063	78
	36	0.1065	0.1091	71
	7/64	0.1094	0.1120	64
	35	0.1100	0.1126	63
	34	0.1110	0.1136	60
	33	0.1130	0.1156	55
6-40	34	0.1110	0.1136	75
	33	0.1130	0.1156	69
	32	0.1160	0.1186	60
8-32	29	0.1360	0.1389	62
	28	0.1405	0.1434	51
8-36	29	0.1360	0.1389	70
	28	0.1405	0.1434	57
	9/64	0.1406	0.1435	57
10-24	27	0.1440	0.1472	79
	26	0.1470	0.1502	74
	25	0.1495	0.1527	69
	24	0.1520	0.1552	64
	23	0.1540	0.1572	61
	5/32	0.1563	0.1595	56
	22	0.1570	0.1602	55
10-32	5/32	0.1563	0.1595	75
	22	0.1570	0.1602	73
	21	0.1590	0.1622	68
	20	0.1610	0.1642	64
	19	0.1660	0.1692	51
12-24	11/64	0.1719	0.1754	75
	17	0.1730	0.1765	73
	16	0.1770	0.1805	66
	15	0.1800	0.1835	60
	14	0.1820	0.1855	56
12-28	16	0.1770	0.1805	77
	15	0.1800	0.1835	70
	14	0.1820	0.1855	66
	13	0.1850	0.1885	59
	3/16	0.1875	0.1910	54
1/4-20	9	0.1960	0.1998	77
	8	0.1990	0.2028	73
	7	0.2010	0.2048	70
	13/64	0.2031	0.2069	66
	6	0.2040	0.2078	65
	5	0.2055	0.2093	63
	4	0.2090	0.2128	57

Percentage of Full Thread Produced in Tapped Holes

Tap	Tap Drill	Decimal Equiv. of Tap Drill	Probable Hole Size	Percentage of Thread
1/4-28	3	0.2130	0.2168	72
	7/32	0.2188	0.2226	59
	2	0.2210	0.2248	55
5/16-18	F	0.2570	0.2608	72
	G	0.2610	0.2651	66
	17/64	0.2656	0.2697	59
	H	0.2660	0.2701	59
5/16-24	H	0.2660	0.2701	78
	I	0.2720	0.2761	67
	J	0.2770	0.2811	58
3/8-16	5/16	0.3125	0.3169	72
	O	0.3160	0.3204	68
	P	0.3230	0.3274	59
3/8-24	21/64	0.3281	0.3325	79
	Q	0.3320	0.3364	71
	R	0.3390	0.3434	58
7/16-14	T	0.3580	0.3626	81
	23/64	0.3594	0.3640	79
	U	0.3680	0.3726	70
	3/8	0.3750	0.3796	62
	V	0.3770	0.3816	60
7/16-20	W	0.3860	0.3906	72
	25/64	0.3906	0.3952	65
	X	0.3970	0.4016	55
1/2-13	27/64	0.4219	0.4266	73
	7/16	0.4375	0.4422	58
1/2-20	29/64	0.4531	0.4578	65
9/16-12	15/32	0.4688	0.4736	82
	31/64	0.4844	0.4892	68
9/16-18	1/2	0.5000	0.5048	80
	33/64	0.5156	0.5204	58
5/8-11	17/32	0.5313	0.5362	75
	35/64	0.5469	0.5518	62
5/8-18	9/16	0.5625	0.5674	80
	37/64	0.5781	0.5831	58
3/4-10	41/64	0.6406	0.6456	80
	21/32	0.6563	0.6613	68
3/4-16	11/16	0.6875	0.6925	71
7/8-9	49/64	0.7656	0.7708	72
	25/32	0.7812	0.7864	61
7/8-14	51/64	0.7969	0.8021	79
	13/16	0.8125	0.8177	62
1-8	55/64	0.8594	0.8653	83
	7/8	0.8750	0.8809	73
	57/64	0.8906	0.8965	64
	29/32	0.9063	0.9122	54
1-12	29/32	0.9063	0.9123	81
	59/64	0.9219	0.9279	67
	15/16	0.9375	0.9435	52
1-14	59/64	0.9219	0.9279	78
	15/16	0.9375	0.9435	61
1 1/8-7	31/32	0.9688	0.9750	81
	63/64	0.9844	0.9911	72
	1	1.0000	1.0070	64
	1 1/64	1.0156	1.0226	55
1 1/8-12	1 1/32	1.0313	1.0384	80
	1 3/64	1.0469	1.0541	66
1 1/4-7	1 3/32	1.0938	No Test Results Available Reaming Recommended	
	1 7/64	1.1094		
	1 1/8	1.1250		
1 1/4-12	1 5/32	1.1563		
	1 11/64	1.1719		
1 3/8-6	1 3/16	1.1875		
	1 13/64	1.2031		
	1 7/32	1.2188		
	1 15/64	1.2344		
1 3/8-12	1 9/32	1.2813		
	1 19/64	1.2969		

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aste NEWS

In the National Spotlight

ASTE Schedules Nine Seminars

IN A DRIVE to expand its educational services to Society members, to manufacturing management and to engineering personnel in general, the ASTE has scheduled nine seminars for early 1959. Others are planned. The seminars, a function of the national education committee with major assistance from headquarters staff, are designed to present the latest information on production methods.

With a growing market ahead, management problems and decisions involving equipment and tools will require a knowledge of technical progress. ASTE seminars are planned to present the complete story, and to assist management and production people with their critical decisions in tool engineering.

Here's the schedule of "creative manufacturing seminars":

PLASTIC TOOLING FOR PRODUCTION

1M21	Jan. 28, 1959	Sheraton-Palace Hotel San Francisco
1M29	Jan. 30, 1959	Statler-Hilton Hotel Los Angeles

CONTENTS: Plastics in the tooling industry; characteristics of plastics used in tooling today; available properties in plastics; uniqueness of plastics to the designer; advantages and disadvantages. Fabrication of plastic tools; plastic tooling for small parts.

TOOLING FOR METAL POWDER PARTS

1M22	Feb. 4, 1959	Benjamin Franklin Hotel Philadelphia
1M24	March 24, 1959	LaSalle Hotel Chicago
1M23	April 24, 1959	Sheraton-Palace Hotel San Francisco

CONTENTS: Applications of metal powders in manufacturing; machine selection and tooling procedures; product design for metal powders; economics of metal powders; initiating the metal powders program.

ANALYSIS OF METAL-CUTTING METHODS

1M26	March 11-12, 1959	Bond Hotel Hartford, Conn.
1M25	April 9-10, 1959	Benjamin Franklin Hotel Philadelphia

CONTENTS: What's known about metal-cutting today; latest improvements in machining methods; integration of known metal-cutting data and their practical application.

OPTICAL TOOLING AND GAGING

1M27	May 6, 1959	Chase Park Plaza Hotel St. Louis

CONTENTS: Use of optics in industry; use of light in quality control; evaluation and scope of optical gaging; initiating the optical tooling program.

NUMERICAL CONTROL OF MACHINE TOOLS

1M28	Feb. 17, 1959	Sheraton-Cadillac Hotel Detroit

CONTENTS: Latest phases of numerical control; potential of complete control systems; evaluation of current trends; effects on accuracy, tool life, surface finish, and precision in the workpiece; production experiences and programming.

Each single-day seminar will consist of five technical papers; the metal-cutting seminar will have 12 papers. All seminars will feature an open-forum discussion period. Information will be presented concisely, and every effort will be made to answer all questions and to consider all problems.

Registration fee for each one-day seminar will be $30 for an ASTE member, $45 for a nonmember. Fee for a two-day seminar will be $50 for a member, $75 for a non-member. The fee includes all sessions in the seminar, all luncheons and coffee breaks, and technical papers and research reports. Employees of ASTE affiliate companies will be considered in the member fee. Registrants are responsible for their own hotel accommodations.

Seminar Registration Form

Mail to:

Seminar Registration
ASTE
10700 Puritan Avenue
Detroit 38, Mich.

Please register me for the ASTE Seminars.

Seminar No. _____ Date _____

Title _____

Seminar No. _____ Date _____

Title _____

Name _____

Position _____

Company _____

Street _____

City, State _____

☐ Member Chapter No. _____ ☐ Nonmember

☐ Check enclosed ☐ Bill

Posing on the steps of The Cincinnati Milling Machine Co. during fall meeting of the ASTE Research Fund Committee are (left to right) William E. Mahin, president of the Malleable Research and Development Foundation, Granville, Ohio; Harry E. Conrad, executive secretary of the ASTE; Leslie S. Fletcher, ASTE research director; Joseph Sunnen, president of Sunnen Products Co., St. Louis; James R. Weaver, committee chairman and manager of manufacturing and engineering, Westinghouse Electric, Springfield, Mass.; Kenneth R. Beardslee, general manager, Metallurgical Products Dept., General Electric; D. J. Davis, vice president-manufacturing research, Ford Motor Co.; Wallace E. Carroll, president of American Gage & Machine Co., Chicago; Louis F. Polk, vice president and group executive, Bendix Aviation Corp., and president of Sheffield Corp., Dayton, Ohio; and Swan E. Bergstrom, executive vice president of Cincinnati Milling Machine Co. Bergstrom was the group's host for the all-day meeting.

Society Role in Research

RESEARCH, whether you accent it on the first or the last syllable, is a glamor word these days. When you hear it spoken, chances are you'll think of electronic mazes and moon missiles, and echelons of feverish-eyed, smock-wearing scientists. It is difficult indeed to think of it as a job—a usually important but seldom glamorous job, sometimes involving downright drudgery and oftentimes tedium.

Perhaps an unspectacular 61-page paper on "Cemented Boride Composites for Tool Bits" (which is the recently released ASTE Research Report No. 13), or a ponderous bibliography (such as the 6,500-item "Metal-Cutting Bibliography" just completed by the John Crerar Library under sponsorship of the ASTE)—perhaps such things are more nearly the central meaning and spirit of the word research than all the count-downs at Canaveral.

For what is research?

It's a "critical and exhaustive investigation or experimentation having for its aim the revision of accepted conclusions, in the light of newly discovered facts," says the dictionary.

"It's an organized search for new knowledge," says ASTE Research Director Leslie S. Fletcher. "Know-why, rather than know-how, should be its objective. That's the basic difference between research and development."

What is the role of research in your Society? What has the ASTE done, what is it doing, what is it planning to do in this increasingly vital—but notoriously nebulous—field? And what does it all signify to the ASTE member?

The ASTE Research Fund, established by the board of directors in 1950, is a nonprofit adjunct of the Society whose purpose is to catalyze research in the broad field of tool engineering. It is administered by the Research Fund Committee, members of which are permanent appointees. With the recent addition of Dr. Frank E. Myers, associate director of the Argonne National Laboratory, the committee now numbers a dozen—all men of stature from industry and education. One is added annually until the committee membership shall have reached 15. The chairman is James R. Weaver, a past president of the Society and the manager of manufacturing and engineering, Westinghouse Electric, Springfield, Mass.

The group's right arm is Research Director Fletcher of ASTE headquarters, who was hired in 1954 to assist the committee in carrying out its rapidly expanding functions. Fletcher, a West Point graduate and a registered professional engineer in the states of New York and Michigan, brought to the ASTE job some 15 years' Army experience in supervising research laboratories and in buying research for the government, and seven years as president of a commercial laboratory selling research to the government and to industry.

Suggested research projects may be presented to Fletcher and the committee as elaborate detailed prospectuses, or they may float in over the transom in memo form. They may originate during a brainstorming session of the committee itself, or be a concrete request for sponsorship from a research institute or university or industry; or they may come from an ASTE chapter—or from a member.

Whatever their source, the suggestions for research are all welcome, and they are carefully eval-

Dr. Frank Myers New Member of Committee

uated by the committee and the research director.

To be acceptable, a project must measure up to these criteria: fall within the field of tool engineering and not conflict with the proper subject concerns of other organizations; be basic in nature but have practical objectives and applications; be of use to a sizable group of tool engineers; result in a saving of strategic material or manpower, or provide some other economy of operations; and be publishable.

ASTE sponsorship may take the form of "thought buying" (grants-in-aid or fellowships for a research worker on a particular project), or "work buying" (actual laboratory projects done under contract).

Most of the Society's research projects so far have been implemented under direct contract sponsorship. Among contracting parties have been Columbia and Purdue universities and M.I.T., the Battelle Memorial Institute, Armour Research Foundation and the John Crerar Library.

The placing of a research contract is as much a gamble as research itself. As Fletcher says, "You can buy no guarantee of success. The very definition of research makes this so. You must depend on the reputation of the laboratory. . . . You cannot sit down with an engineer or scientist and plan out in detail all of the necessary steps that are to be undertaken. If you could, the project would hardly be classified as research."

Once a decision has been reached by the fund committee to proceed on a given project, a steering committee is set up. This subcommittee is composed of the research director and up to a dozen or more persons skilled in and interested in the particular area of investigation.

The steering committee keeps the whole project "on the track," pointed toward practical results. If the group sees that the project is heading for a blind alley, it can suggest major changes or abandonment to the fund committee. The steering group also furnishes constructive criticism of interim reports on the project, and acts as the clearing house for any ideas that are broached during the investigation.

The Research Fund Committee currently has steering committees at work on its continuing plastic tooling, metal-cutting, metal-stamping, borides and cutting fluids projects. Personnel serve until the project is finished. And the project isn't finished until the data obtained are disseminated to the tool engineering profession. The results of all investigations are published as research reports (there have been 18 so far). They may also appear as articles in THE TOOL ENGINEER or other technical publications, and may be presented at ASTE meeting and before other technical societies.

Research is costly. The ASTE fund has in the past depended on (1) allocations by the Society and (2) contributions from industries. An attempt to accelerate the attainment of the complete subsidy of ASTE research activities by industry has been discouraging because (1) industry usually wants a proprietary interest in the results, whereas the Society is interested in publishable research for the benefit of all; and (2) many industries find it difficult to justify to their stockholders any large outside expenditures for such nonproprietary knowledge.

Program Faces Funding Dilemma

Fletcher got to the heart of the research funding problem when he told the fall meeting of the Research Fund Committee in Cincinnati:

"We have reached a critical period, if not a turning point, in the life of the ASTE Research Fund. We have advanced from a dream to a reality . . . from an unknown to a well-known and respected organization. We are changing from an organization that sponsored research work from money made available by the ASTE to one that must raise funds from industry or other sources if it is to sponsor any future research."

To solve the money dilemma, the committee has suggested that the ASTE offer corporate memberships, perhaps called "research associate memberships," at a nominal cost—$100 or so a year—and earmark all such dues for research. This plan is being studied by the board of directors.

Looming large in future research plans is the Society's dream of building an ASTE Research and Education Center. Fletcher thinks a minimum budget for the Society to operate an adequate research laboratory would be $100,000 a year.

Some on the committee disagree. They cite the elaborate facilities of big industries and institutions already in existence, and fear that an ASTE laboratory operated on such a budget, or even on one substantially larger, would be inconsequential.

But other members see justification for the ASTE going into the research business itself—they point to the individual tool engineers and the small companies without large research staffs who rely for thought stimulation and work ideas on the ASTE research reports. They see unlimited opportunity in tool engineering for research done by people without dollar marks in their eyes. . . .

However these problems may be resolved, it is a safe assumption that the ASTE is in research to stay. For the propagation of new knowledge is the reason-for-being of any technical society.

The ASTE is getting big, so big that THE TOOL ENGINEER fears names will be buried by numbers. We don't want to lose sight of the fact that the Society, after all, is made up of some 39,000 individuals. To restore the intimate perspective—to look at the trees despite the forest—here's some news that's not national or regional, or even chapter level, but strictly personal. It's the fourth in a series of profiles of tool engineers.

Ann Baker

Meet a Woman Tool Engineer

by **Suzanne Olson**
associate news editor

FROM ICE CREAM to aircraft components in a matter of ten years is quite a change of pace. The path that led blonde and petite Ann Baker from the former to the latter is as interesting as it is circuitous, and perhaps touches a more varied set of jobs and experiences than the average woman faces in her entire adult life.

But then, Ann is anything but average, from her job to her hobbies, and her talents to her accomplishments. No tool appalls her, except the kind that hangs by the kitchen stove. To her, blueprints don't pose a tenth the problem that a recipe does. For, in her own words, "Believe it or not, I can't cook!"

As tool planner for Rohr Aircraft in Riverside, California, a once-peaceful residential town just now being wakened by its lusty neighbor Los Angeles, Ann has seen Rohr's aircraft component production treble in the two years she's been there. No Jenny-come-lately to the aircraft tooling business, she got her basic experience from 1951-56 with Douglas Aircraft in Santa Monica (at a job she had to talk hard and fast to get), moving through the ranks from riveting to receiving inspection to spares to shipping to precision inspection, and then to tool planning.

Ann recalls the opposition with which her pleas for a crack at the riveter job were met. All kinds of arguments were handed her, from the first screening interviewer to the top hiring boss—arguments such as "We don't have jobs open for secretaries now," to which she answered, "That's fine, I can't type." Other threats of "It's dirty, it's hard work,

Tool Planner Ann Baker checks some engineering changes requested by Rohr's prime contractor, Boeing Aircraft, with her supervisor, Steve Derkack (left) and his assistant, Ed Schaefer. Parts for Boeing's 707, KC135, and B52 are fabricated by the Riverside plant.

you're too small, you'd have to wear coveralls" failed to discourage her. To all of this she replied, "I'm stronger than I look, I don't care, and I'd like to try."

Two air tragedies—the death of a pilot friend who went down in the Atlantic, and the facial mutilation of her brother in an air raid over Sicily—sparked her interest in learning all she could about aircraft. She hoped to invent lifesaving devices for pilots flying at low altitudes . . . a hope not based on wishful thinking alone. For Ann is an avid do-it-yourselfer, and enjoys experimenting with new materials. Besides, inventor's blood runs in her family. Her uncle was the late Nelson Welk, a prolific inventor and holder of some 60 patents for original ideas and improvements of products in the office equipment field.

Through the influence of one of her superiors at Douglas, Ann got a thorough grounding in aircraft fabrication. He saw that books were ordered for her to read, and as soon as she finished one, another was ordered. She studied the complete setups of the DC3 and the DC6 . . . material, air pressure, hydraulics, pyrotechnics, flight controls, oil dilution systems, antenna masts, propellers—"well, the works," says she.

At the same time she attended night classes, at Santa Monica City College for advanced math, blue print reading, and production and tool planning, and at Van Nuys High School for two years of machine shop.

After three years in tool planning with Douglas, Ann moved on to Adams Rite Co. as methods planner and tool coordinator, where her job consisted of identifying some 4000 tools, figuring out what they made, and to what configuration, classifying them as to part number and tool number and setting up a tool vault.

Now at Rohr Aircraft, which makes such aircraft components as power packs and the flight control mechanisms—stabilizers, elevators, ailerons, etc.—of tail and wing sections, Ann checks the tool planning of four lead men for error before it gets to the regular plan inspection department. Her job title is tool planning instructor and checker.

The battle of the sexes raged hotly when it was first decided a woman would check the men's work. "It didn't go over at all with the fellows," says Ann. "But my supervisors and the company backed me up, saying . . . 'She has proved she's right 95 times out of 100, and if she can do the job—well, she does it'.

"It was rough for two or three months but, one by one, they all came around and apologized. They explained it was just the fact that a woman was passing judgment on their work that upset them. Now they come on their own for instructions on how to do certain jobs."

At Rohr, as in the Riverside chapter, she's known as "George," and though she most certainly doesn't look it, she considers herself—and insists on being—"just one of the boys." Incidentally, she handles the advertising for the Riverside chapter bulletin, *The Paradise Valley Tool Engineer*.

Ann is not a native Californian—but then, who is? She was born in Athens, Ohio, in 19- . . . well, more than thirty years ago. Her connection with ice cream came in the early years of her marriage when she and her husband opened a wholesale and retail ice cream store, and expanded it into a chain of five stores in St. Joseph, Mich. Ann kept the books and ran the business end of the partnership. After six years and two children, the partnership was dissolved by mutual consent, and Mom and babies traveled west to start afresh in California.

Now the sole breadwinner, Ann started a small business of her own, designing and making jewelry, purses and novelties, and incidentally gaining skill in the manipulating of leather, plastic, and other materials which would later stand her in good stead in her work to design safety devices.

She and her daughter Joan reminisce about the good times they had during summer vacations, traveling around the country. Ann would make up a supply of her handicrafted items, pack them and the children into her car, and take off to tour the country. They would meet expenses on the way by selling the items to gift shops and, when finances ran low, would stop over and make up a new batch. Although this is hardly the approved way to get an education, both children—now grown—agree that this "education on wheels" taught them more about this country and its people, and also about human resourcefulness, than they ever learned in school.

During the same period, Ann worked as a private investigator and undercover agent for law firms,

Ann and three lead men with whom she works stop on a tour through the machine shop to watch a lathe operator filing a chamfer. From left are Bob Rogar, Al Stevens (minus glasses) and Joe Robinson.

private businesses, and the Better Business Bureau. She had her finger in such pies as uncovering a shady furrier's fraudulent representation of cheaply made furs as the genuinely expensive article. "All a matter of slitting and sewing together the skins so closely that on the inside you can't see the leather for the stitches," she explained.

This assignment saw her in the role of a prospective buyer who wanted to keep up with the Joneses, minkwise, on a clerk's salary. She sought the aid of the suspected furrier, who obligingly came through in true crime-story fashion and ushered her into a secret vault concealed behind an innocent-looking wall. Her problem—to get him to tip his hand, and still get herself out of the vault, unsuspected and in good health, and with an entree for a return peek at the forbidden furs. Did she manage? This story is, of course, proof that she did.

Another excerpt from the case book of "Ann Baker, Undercover Girl" involved an incident so notorious that a book and a movie later were made of it. In this case, Ann worked to keep the defendant, in her opinion an innocent man, from the gas chamber. Such ulcer-producing jobs began to lose their appeal, and Ann decided to settle for something less nerve-wracking—like the riveter's job at Douglas.

Now that Ann has staked her future, more or less, on her ability to read blueprints and specify methods and tools to produce an airplane's vital parts, how does that future look? Despite the antagonism she faced at first in all-male surroundings, she is optimistic that women at Rohr will more and more be accepted on the merit of their work, rather than rejected for their sex. And her own future looks bright. There are now several women working with her in the tool planning department, but Ann ruefully acknowledges she has not gained any ground in getting them into ASTE as yet.

Since outsmarting racketeers is no longer part of her life, I asked her what, besides her work, kept her busy. Seems there's a lot.

One pastime, lucrative as it is time-consuming, is buying, refurbishing, and renting or selling houses. "I buy the worst looking house on the block," Ann claims, "and then I move in, redecorate [she does her own painting and paper hanging], fix up the plumbing [she does that too], improve the lot and make any other repairs that are needed, and then sell it. I always make money on the investment, and it helps to improve the neighborhood, too, so everyone's happy."

A black coffee table squatting in her living room demanded an explanation. Ann laughed, and said it was the last of a whole houseful of furniture she had once lined up in the yard of one of her Van Nuys houses and sprayed black.

"Grandma" Ann succeeds in holding at least one of her two grandsons' attention with the volume of Grimm's Fairy Tales. Billy, at five, is perhaps better able to appreciate them than a disinterested three-year old Gregory.

"The house was divided into apartments, and the furniture that came with the house when I bought it was sturdy—but nothing matched. I figured if everything was black, the pieces could be switched from unit to unit as the needs of the tenants changed, and everything would match."

At daughter Joan's house is still another job for "Grandma"—baby-sitting with two grandsons.

Joan Guess, matching her mother's blonde good looks with a dark-haired youthful beauty, is following in Ann's footsteps in several ways. She, too, is raising two children all on her own, and she, too, works at Rohr. Joan, however, is on the graveyard shift. With a touch of her mother's ingenuity, she takes a frozen TV tray-dinner to work, slips it into the heat-treat oven for two minutes, and scoffs at the other employees eating a cold sack lunch while she enjoys a well-balanced hot meal.

Ann's currently making plans for more experimenting and research into the properties of materials. Besides her safety devices, she's also working on taking the rubber smell out of elasticized garments such as bathing suits and feminine "underpinnings."

There are always plenty of projects to work on, she feels, if you have the imagination to think of them, the ingenuity to adapt known methods and materials to new uses, and the brashness to attack almost any unsolved problem with common sense and intelligence. There's just one thing missing, among her many skills. A look at her empty refrigerator, and I was ready to believe her. She *simply can't cook.*

Martin Co. guide explains the chem-milling process to touring Denver ASTE members. More than 286,000 gallons of solutions—alkaline cleaners, etchants and surface coaters—are kept continuously flowing in the 15 tanks in the plating room. Compressed air provides continuous agitation. All 19,000 gallons in each tank must be kept within 10 degrees of the desired temperature, the visitors were told.

denver tours birthplace of Titan

Here's a mountain-top view of a Titan ICBM captive test stand. Paved road is one of several connecting the Martin Co. test area with the central manufacturing and engineering facilities nearby.

BECAUSE of the rigid security measures required to safeguard the still secret Titan intercontinental ballistic missile, only 75 members of Denver chapter could be granted permission to tour the manufacturing areas of the Martin Co.'s missile site near Denver. All 75 showed up to take the tour, with Henry Sandlas of Martin-Denver acting as host.

Chapter 77 members saw the modern tools and techniques used to produce the newest and most advanced ICBM in the U.S. arsenal. The missile is the product of thousands of engineers and other technical personnel, many of whom are long-time members of the Denver ASTE organization.

The Martin facility includes a 155,400-square-foot administrative and engineering building, a 306,700-square-foot factory building, as well as complete testing laboratories and firing stands in the nearby mountains. —*D. S. Taylor*

Denver chapter's famous "Silver Anniversary Bell" in the right foreground brought the dinner meeting to order. Eighty-four members and guests attended, then 75 of them went on to tour the Martin plant.

cleveland report on

Foreign Competition

FOREIGN machine tool builders and tool engineers are quickly catching up with the United States, and competition—already keen—will get even keener after the first of the year, according to Alfred E. Drissner, vice president-engineering for the National Acme Co. and a veteran observer of European industry.

Speeaking to members and guests of Cleveland chapter at the Oct. 9 meeting in the new Cleveland Engineering and Scientific Building, Drissner cautioned the American tool industry to brace for the 1959 advent of duty-free sales among the six major European countries in the free trade bloc. "They are producing large quantities of tools and machinery, and they are working hard to increase their exports," he said.

"Already I have heard some U.S. manufacturers complaining bitterly about imports. We cannot expect to head off these imports with protective tariffs—the Europeans would immediately reciprocate—but only with better and cheaper tooling. If we want to export to the free-trade countries, we must let them import. It's a fifty-fifty proposition.

"And anyhow, can U.S. businessmen justifiably complain when their exports total $10 billion a year in contrast to annual imports totaling $2 billion?"

In addition, Drissner said, export and import to the satellite countries of Poland, Czechoslovakia and Hungary will open up. It is there that U.S. manufacturers must especially stand ready to meet competition head-on, he warned. That competition will be from the Soviet.

"The Russians have indicated that in the machine tool line they are now completely independent. They say they can produce not only their own requirements, for peace and war conditions, but also those for China, under their 1953 agreement."

No Serious Threat Yet

In a question and answer period after his talk on "Foreign Competition and the Tool Engineer," Drissner elaborated on the threat of Soviet encroachment in the machine tool export business. Fear is quite widespread in Germany and France, he said, of a Russian export invasion of European markets after January 1.

"As of now, Soviet competition—even when it can sell a horizontal boring mill, for instance, at $12,000 when the U.S. counterpart sells for $40,000—is no serious threat to the European or U.S. market. This is so because Russia's machines are not up to date, for the most part, and are mostly copies of European and American-made machines.

"But they are built strong enough to take carbide tooling—and, especially significant, the selling prices can be controlled by the Soviet government to meet any competition, without any loss to them. In fact, the Russians could give the machines away in exchange for some other raw material controlled by the capitalistic countries. Russia just can't lose money; the machines, the labor, the product all belong to the state. That's hard to compete with."

As an indication of the growth of the European machine tool industry, which Drissner has observed for nearly half a century in his work with the National Acme Co., he cited the tremendous spurt in the number of tool manufacturers in Germany in the last generation. Before World War II, he said, there were only 400 machine tool builders in all of Germany. Under the impetus of war and postwar recovery, Western Germany alone now has 600 different machine tool builders, modernly equipped and doing exceedingly well. This same expansion, Drissner pointed out, holds true to a lesser extent in Italy, France and Holland. With their low labor rate and conscientious workers, they can more than compete with American products.

U.S. Answer to Competition

"To meet these one-sided conditions," Drissner said, "especially in the field of drill presses, milling machines and lathes, which create the greatest competition, more and more American companies are manufacturing their products in Europe, where labor and material are cheaper, then importing their own products to the United States."

An important feature of European manpower is the ability and conscientiousness of the worker. Every young man has to decide what line of work he wants to follow and then must pass his apprenticeship under government control. In Germany, for example, manufacturers are obliged by law to have 15 percent of their young employees go through apprenticeships, Drissner said. In this way they have a good and unending supply of young employees coming along in the various fields.

Among the points Drissner made were:

Foreign Competition

- Key requirements of the foreign market are simplicity, power and accuracy.
- The foreign tool engineer, forced to deal with short runs, adopts modified mass production tooling for universal machines.
- Carbide and high-speed steels are being used side by side.
- The throwaway bit is becoming more widely used, and a newer method now being used in Europe is that of gluing the bit to the holder. Gluing seems to cushion the carbide bits.
- Holders are rapidly being standardized for faster change-over. (The ISA tolerance system is the accepted base for all standardization.)
- Ceramic tools are being tested. Used in Europe to some extent since the first World War, they have heretofore been impractical because they cannot be manufactured uniformly enough.
- Single point tools controlled by followers are used more than multitooling.
- New methods of metal removing are being tested widely, such as spark erosion and ultrasound. Tracing tools are becoming widespread.

Drissner was born and educated in Germany and came to the United States in 1904.

In addition to his speech, he showed a color-sound movie on the Volkswagenwerk at Wolfsburg.

Guests at the dinner meeting included Gustav W. Brethauer of the German Consulate in Cleveland. Coffee speaker was ASTE past president, Harry B. Osborn, Jr., who told his fellow chapter members of his recent trip to Japan and his projected trip to Turkey.

Sydney chapter visits factory

Examining one of the host company's products during Sydney chapter's tour of the Coventry Gauge & Tool Co. in Sydney are (left to right) a director of the firm; J. V. Horsnell, chapter editorial chairman; C. Colton, secretary; and Chairman C. Curtis. One hundred twelve members went on the plant visit.

Smoking break during second-day sessions at Baltimore finds many of the crowd examining a numerically controlled positioning spacer table. This prototype table, rigged up with temporary wiring, was specially shown to Baltimore conferees two months before its scheduled formal introduction.

baltimore workshop on TAPE CONTROL

THREE HUNDRED people with an eye on the future turned out for a two-day session which the sponsoring Baltimore chapter called "The First Workshop on Tape Control for the Small Shop."

Nine companies specializing in all facets of tape control made presentations in a candid bid to gain acceptance of their wares among machine and tool and die shops which generally deal in small-lot production. They attempted to answer such oft-heard questions as: What is tape control? When should it be used? How much does it cost? How can it reduce my costs? Must I buy the entire package? Why will it increase my production?

The technical talks, presented Oct. 24-25 in the auditorium of north-side Baltimore's Mervo Tech School, followed a kickoff banquet the preceding night in the Sheraton Belvedere Hotel. There, 70 ASTE members and their guests, having been regaled with $5.50 meals and some priceless geniality from the toastmaster, Society Vice President David Schrom of York, Pa., heard some stiff words of warning from another Society vice president, Wayne Ewing of Los Angeles.

The Californian cautioned that Americans must face up to the fact that the Russians have decided that education is the best way to win their place in the sun—or on the moon. Education, he said, is nothing less than a passion with them.

Ewing called the group's attention to the recently published report on the 8000-mile tour of the USSR made by a picked handful of leading U.S. educators. These expert observers found one overriding theme throughout the land: "Reach and overreach the U.S.A. through education." They found frequent postered admonitions for the Russian citizens to equal and excel the United States, in higher education, industrial productivity, military power, and all other aspects of modern life.

Dynamic Spirit of Competition

Ewing said a dynamic atmosphere of progress and an apparent sense of destiny in Russia have spread a spirit of competition, especially in educational circles, that is of tremendous significance—and peril—to us who are competing with them. As an example of this surge toward power, he said the Soviet production rate has increased 22 times in the past 40 years, while the U.S. production rate has only doubled.

Our concern, he said, should be to "get enough people to recognize the need for educational overhaul and emphasis. Then we can work out the problems in our own areas, according to our own needs, our own politics, conscience, and financial capabilities."

He noted that the chief difference between the Soviet system and ours is that theirs is directed to-

TAPE
CONTROL

J. M. Morgan, Jr., speaking to the crowd in the Mervo Tech Auditorium on "Numerical Control for the Small Shop," gave his own interpretation of the space age—"plenty of space for development." Morgan is manager of the development research department of The Cincinnati Milling & Grinding Machines, Inc.

ward making Russia the greatest nation in the world, while ours aims at the development of individuals as cooperating members of a free society. He declared that the ASTE, through such grass-roots efforts to spread tool engineering education as the Baltimore workshop, was trying to do its part to stimulate technological advance in the United States.

Technical speakers and the companies they represented were: G. S. Knopf, manager of the controls section, Bendix Aviation Corp., who spoke on "Practical Applications of Numerical Control to Contour Machining"; W. B. ("Wally") Brainard, chief engineer in Servo Machine Tool Div., Kearney & Trecker Corp., "The True Role of American Control"; F. W. Burdett, chief sales engineer of aircraft machine tools, Giddings & Lewis Machine Tool Co., "Numericord—Tape Continuous Path Control"; D. N. Smith, manager of research, Jones & Lamson Machine Co., "Point-to-Point Position for Operations Such as Drilling, Punching, Spot-Welding"; L. E. Laux, Chapter 13 past chairman and chief of research and development at The Martin Co., "Preparing for Numerical Control"; S. C. Clark, sales engineer in specialty control department, General Electric, "Point-to-Point Numerical Positioning Control"; H. Lindhult, Hillyer Corp., "Maximum Flexibility Required to Obtain Greatest Benefits from Tape Control"; J. M. Morgan, Jr., manager of development research department, Cincinnati Milling & Grinding Machine Co., "Numerical Control for the Small Shop"; and C. R. Hibbard, sales manager, Fosdick Machine Tool Co., "Numerical Control, Point-to-Point Positioning on a Precision Boring Machine."

Among salient points made by the speakers were that the true role of tape controls is building the machinery that makes consumer goods, rather than making the goods themselves; that the success of any numerical control system depends heavily upon the excellence of the controlled machine, which must have stiffness and freedom from backlash; that an 8-channel, 1-inch tape is gaining favor as the standard vehicle for numerical control systems; and that numerical controls aim at small-lot flexibility and improvement of machining efficiency.

One of the speakers said, "There's not a plant in the country that a good tool engineer couldn't go into and show where tape controls will fit in efficiently."

Another said that tape controls, by cutting setup time, could justify shorter production runs, reduce inventories, improve quality of product, eliminate jigs and fixtures, and eliminate operator errors.

Conference participants viewed tooling displays during luncheon breaks.

Three Chapter 13 members, meeting in the hall between speeches, talked about the weather and the workshop, and agreed that both were going fine. Left to right are Glenn E. Borton, program chairman; James Rodgers, chairman; and Alexander Wolak of Flight Refueling.

Catskill Region Chapter Chartered

Catskill Region Chapter 151 has been chartered with 101 members. Of these, 59 were new members and 42 transfers, mostly from Mid-Hudson Chapter 74.

ASTE President George A. Goodwin officiated at the ceremonies, held September 17 at the Kingston Hotel, Kingston, N. Y. National Director Joseph L. Petz of Pleasant Valley, N. Y., was toastmaster.

Installed as officers of the new chapter were: Attila G. V. de Illy, chairman; John Kelley, first vice chairman; Andrew Kearney, second vice chairman; Arthur Richter, secretary; and Bernard Martin, treasurer.

Among guests at the chartering were Richard Whalen, general manager of IBM, Kingston; Prof. William Mullee, industrial engineering department of New York University; Ray Morris, past national president of ASTE; Paul Dillberg, chairman of Hartford Chapter 7.

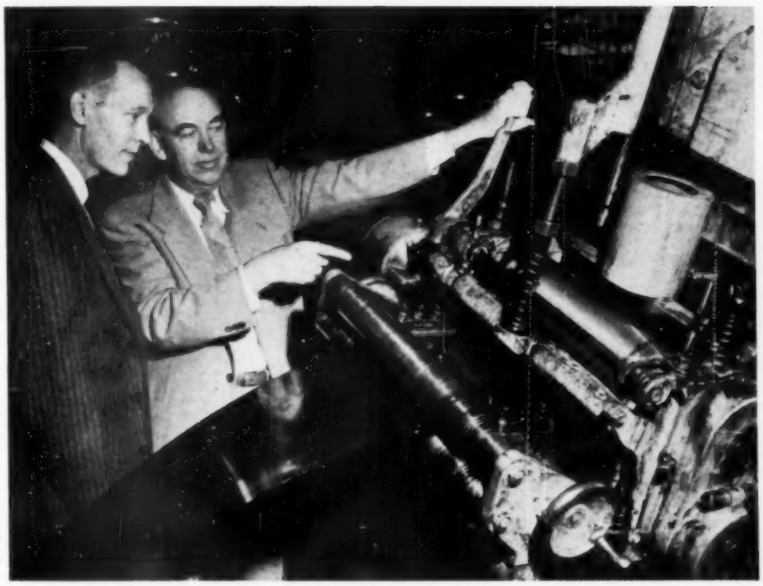
Robert P. Crago, director of engineering of IBM's Military Products Div., was featured speaker.

Observations in Europe

At the first regular technical meeting of Catskill Region chapter, the manager of the machining development laboratory for General Electric Co. in Schenectady talked on "How Machinability Increases Productivity" and narrated his experiences traveling through European industrial centers.

The speaker, Dr. William W. Gilbert, made these observations on European industry: In England, a large research group is serving a great number of industries in solving their technical problems; in Russia, widespread standardization is under way; and in Germany, the art of removing chips has advanced into electrochemical and ultrasonic fields. *—Victor F. Patience*

CATSKILL REGION—New Chairman Attila G. V. de Illy accepts charter from National President George A. Goodwin during ceremonies at Kingston, N. Y.



WORCESTER—Chairman Daniel W. Hoyt (left), gets an explanation of an operation at the Worcester Pressed Steel Co. from the plant manager, Maynard Carter, during the chapter's tour of the factory. Later the same day, 68 members and guests heard Neil Van Deusen, plant manager of V & O Press Co. Div. of Emhart Mfg. Co., Hudson, N. Y., talk on "Presses and Automation." *—Robert A. Cusson*

250 Attend Seminar On Metal Cutting In Massachusetts

A metal-cutting seminar, featuring 11 speakers and product displays by area firms, drew 150 members from Northern Massachusetts chapter. The sessions were held at Athol Regional High School, in Athol, Mass.

Each speaker was allotted a 50-minute session, and the program was so arranged that those attending could sit in on four sessions of their choosing. A general question and answer period, at which all the speakers became members of the panel, capped the all-day program. Robert Hurst, carbide engineer for Union Twist Drill Co., was moderator for the panel.

Program chairman was chapter Vice Chairman John W. Turton, Greenfield Tap & Die Corp.

—James A. Ballou

Long Island Hears Talk on Roll Forming; Ewing Is Visitor

Roll forming—the chipless machining process that is rapidly gaining converts—was explained for 100 members of Long Island chapter by Richard Cogan of General Electric Co.

Cogan said the technique, also called hydrospinning and flow turning, has been patented in this country since 1933 by the DeLaval Co. The television industry provided the impetus for the recent interest in roll forming. By conventional methods calling for a great deal of equipment and manpower, Cogan said, seven draws were required in the production of the metal housings for picture tubes; roll forming, in contrast, produced up to 120 pieces per hour per operator.

Wayne Ewing of Los Angeles, ASTE vice president, was an unofficial guest.

PITTSBURGH—Robert E. McKee (at microphone), past chairman of the national education committee and now a consultant member of the group, gives the October meeting the scoop on the soon-to-be-published "Science and Application of Metal Cutting." McKee is training director of the R. K. LeBlond Machine Tool Co. Left is Don Overcashier, chapter program chairman, and right is Walt Kiefer, chairman. Also on program was presentation of $400 ASTE scholarship award to Zane Kuder of the Penn State Extension School at McKeesport, and an outstanding student award to Thomas D. Pullin, senior at McKeesport Vocational High. —*Russell L. King*

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305 Boys Turn Out For Student Industry Day at Muskegon

Muskegon chapter's Student Industry Day, an annual program designed to create interest in tool engineering careers among the area's seniors and to show the great need for them in the field, drew 305 students from the nine high schools and one community college that participated.

Chapter 111's education committee compiled a list of potential engineers and assigned the youths to the kind of plant that featured the type of engineering each student had previously indicated an interest in. Twenty-six plants cooperated.

Each school held meetings beforehand for its interested students, briefing them on topics pertaining to engineering, on what the participating plants manufactured, and on some of the things to look for while on tours.

On the big day—Oct. 7—all Muskegon students mustered at Catholic Central High School, where they heard ASTE Education Director Gilbert Seeley discuss the advantages of a tool engineering career. Another group of students from the Grand Haven, Mich., area heard Seeley at luncheon.

Plants provided transportation. The boys were divided into small groups for the tours, and were encouraged to ask questions. Afterward, group meetings of the students and their engineer-guides were held at each plant.

Cochairmen of the education committee are Joseph Reddam, chief manufacturing engineer, Muskegon Piston Ring Co., and Edward Huttenga, director of education at Hackley Manual Training School. The 10 other members of the committee include representatives from industry and school faculties.

Editor Discusses How Moscow Designs

Seventy members and guests of Cincinnati chapter heard a talk on "How Moscow Designs" at the Oct. 15 technical meeting in the Engineering Society Headquarters.

The speaker, E. J. Tangerman, editor of *Product Engineering*, said the Russians operate as a corporation, American style, with one added feature—police power. He described the Soviet as a land of terrific contrasts, where the new and the old coexist. But it is moving forward rapidly, the editor warned, and one of the most important factors in this advancement is ENIMS, the machine tool institute. —*Clarence Keller*

ASTE Vice President Sees Bright Future For Tool Engineers

Dale Long, ASTE national vice president and past chairman of Chicago chapter, spoke to the Oct. 13 dinner meeting of Chapter 5 on the rosy future ahead for those tool engineers who have the foresight to prepare themselves for it.

Long cited three major reasons why he believes there are ceilings unlimited before the tool engineer. First, he said, rapid population growth means an expanding market and a constantly multiplying demand for consumer goods. The present U. S. population of 175,000,000 will spiral to 192,000,000 by 1965. Second, he pointed to the advance in the science of management, asserting that management can no longer "fly by the seat of its pants" but must have facts, proof and tested information upon which to base its decisions. This emphasis on research, manufacturing and financing—all tools of management—will mean an accelerated demand for capable trained men, many of them in the tool field. Third, Long called attention to the unprecedented advance in technology which will inevitably create more demand for qualified tool engineers. *—Edward Schnell, Jr.*

Granite State Chapter Conducts Plastic Seminar

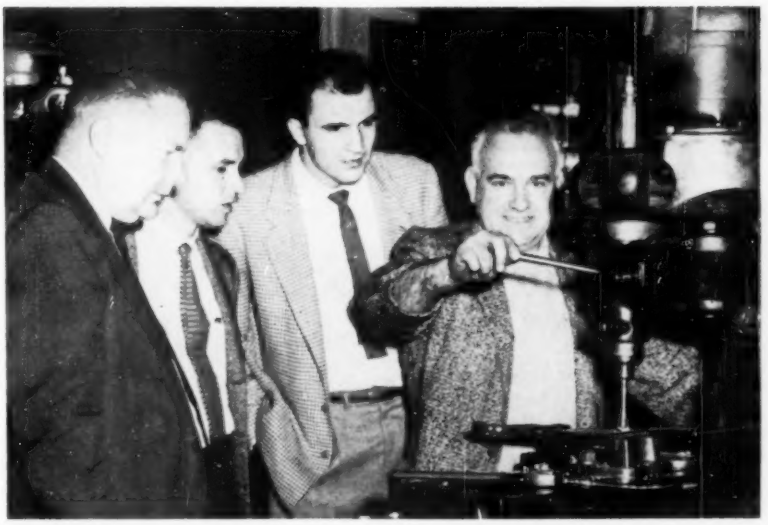
Some 70 members of Chapter 86 attended a plastic tooling seminar at General Electric Co.'s Meter Department at Somersworth, N. H., on Sept. 27. The members present included representatives from New Hampshire, Maine and Massachusetts.

First of its type to be conducted by the chapter, the seminar was arranged by the education committee consisting of Jacob J. Repetto of Clarostat Mfg. Co., Richard N. Wiley and Jacob Mutzbauer of GE.

The opening paper was by Alden R. Joy of Clarostat, who discussed the production tooling and development of the plastic product. A. A. Lawson of Malpar Inc., Falls Church, Va., explained some of the more technical phases of producing plastic assemblies for military requirements.

Willard Crockett, GE plastic tooling specialist, discussed the history and progress of plastic tools and, with the assistance of GE apprentice Robert Legere, demonstrated use and applications of epoxy resins. *—E. F. Symanski.*

Erie Sponsors Tool Conference



ERIE—Bernard Trocki of Trocki Tool Co. demonstrates adjustable drill for visitors at all-day tool conference sponsored by Erie chapter Oct. 4. Registrants heard five speakers at the workshop, held at Alliance College in Cambridge Springs, 25 miles south of Erie. *—Andrew Plaza*

Steel Rule Dies Explained to 200 at Detroit

Two hundred tool engineers from Detroit chapter attended the Oct. 16 program on "Making of Steel Rule Dies." Die models on display backed up the two speakers in what was described as one of the best audience participation technical sessions of the year.

Edward Till, chairman of the chapter's automation committee, introduced William H. Eichelman and Paul Richards of the J. A. Richards Co., Kalamazoo, who related the history and described the uses of steel rule dies.

Since their first utilization for paper box blanks in 1879, steel rule dies have built a wide reputation as economical timesavers, according to the speakers. Their usage now extends to nearly all industries that fabricate materials in odd shapes, including aluminum, sheet metal, leather, plastics, and so on.

The die pads are usually made of plywood, which holds the shear or rule and punch in position. Strippers are of hard rubber or cork held in place with cement. The rule and punch are manufactured from a high-carbon, high-vanadium steel.

Chairman Tony Rogers presented membership pins to 27 men.

—Ken Jenks

DETROIT—Lined up behind display of steel rule dies are Bernard J. Wallis, first vice chairman; Kenneth Jenks, editorial chairman; Paul Richards and W. H. Eichelman of the Richards Co., speakers of the evening; and Chairman Tony Rogers.

chips and chatter

Little Rhody

H. B. Deuberry, engineer at Military and Special Product Sales, was the speaker at the technical meeting Oct. 2. Deuberry spoke on the historical background of optical comparators and how they fit into the present-day need for faster and less costly inspection. His talk was supplemented with slides showing the internal construction of optical comparators and the many ways they can be used with accessories to gage "impossible" dimensions.

TUCSON—Examining a newly patented engine on display at the Oct. 14 technical meeting are (left to right) Mechanical Engineer Holmes, of Hussey Engineering Co., who developed the engine; Fred Kresler, chief tool engineer for Hughes Aircraft at Tucson and the chapter's representative on the Chamber of Commerce's Industrial Development Committee; and Ed Hussey, inventor. Engine operates on a wobble plate principle; the plate, driven by pistons from 16 cylinders, floats on ball bearings and is independent of the crankshaft. Tucson industrial leaders have asked the chapter to provide manufacturing estimates for limited production. *—J. W. Vincent*

Mississippi

Forty-three members attended the Oct. 10 meeting and plant tour of Vickers, Inc. Robert Mezger, service manager, gave the history of hydraulics used in ancient times to irrigate land, and modern hydraulic applications, using Pascal's law.

Monadnock

Richard H. Gale, manager of the Materials Development Laboratory of the Nuclear Div. of Combustion Engineering, Inc., was speaker at the Oct. 16 meeting. Dr. Gale described the advantages and disadvantages of types of nuclear power sources, and compared nuclear power potential with present available sources. The talk pointed up the need for new methods of producing electricity economically.

Greater Lancaster

Forty-three persons at the October dinner meeting heard S. J. Barber, manager, Metal Working Products Dept., E. F. Houghton & Co., speak on the chemical and physical aspects of straight and soluble cutting oils. He also reviewed the objectives being sought with the synthetic coolants.

Kalamazoo

Approximately 75 members and guests attended the plant tour through Atlas Press Co. Sept. 25. The company displayed many of the machines used in the light machine tool field. The machines that were in action were the hydra-cycle, a semiautomatic boring and turning lathe, the Clausing vertical milling machine and the Clausing 13", 15" and 17" geared-head lathe.

Paterson

About 60 members turned out for the technical meeting Oct. 6, where O. J. Seeds, manager, Alloy Sales, Cerro de Pasco Sales Corp., conducted a technical session on "Bismuth Alloys." A group from Don Bosco Technical School, accompanied by the machine shop head, was present.

Syracuse

Chairman of the Syracuse chapter scholarship committee has announced that the ASTE scholarship award has been given to Anthony Tomarchio of Canastota, N. Y. This was the second award Tomarchio has earned from ASTE as a result of his outstanding record at Clarkston College. He will further pursue his education toward a degree in mechanical engineering, specializing in management.

Elmira

Carl L. Saltzman, manager of Control Systems Co., division of Hancock Industries, spoke to 62 members at the technical dinner meeting Sept. 8. His talk covered data processes, marketing and managing.

Central Connecticut

Oct. 1 was the date of the dinner meeting where 125 members heard Henry Mack, co-owner of Whip City Tool & Die Corp., speak on the design and construction of progressive dies. Mack's wide experience in a variety of tooling problems has given him an excellent background in the approach to many problems of design and strip layout facing the tool engineer.

Kokomo

Smith Higgins, Ph. D., director of Indiana University Center at Kokomo, addressed the chapter on "Some Aspects of Complex Numbers." The meeting was designated Past Chairmen's Night in honor of J. B. Linn, first chairman, and Ken Runstadler, second chairman.

Lansing

Seventy members attended the Ladies Night meeting Sept. 20, where Fred R. Dowling, Ph. D., Michigan State University instructor in communication skills, spoke on humor.

Philip Gannon, superintendent of Lansing Community College, gave a short talk on the college; Marvin Bunting, national staff administrator of ASTE, spoke on ASTE and its principles.

Keystone

At the Oct. 20 technical meeting, Frank L. Allen, Jr., optical tooling engineer for Charles Bruning Co., Inc., spoke to 53 members on the use of optics in measurement and manufacturing. Coffee speaker was Joseph G. McGowan, industrial commissioner of Scranton Chamber of Commerce.

Schuylkill Valley

One hundred twenty members and guests participated in a plant tour of the Alcoa Co.'s aluminum extrusion plant Oct. 14.

Kansas City

Leslie H. Landrum, director of process development of the Spencer Chemical Co., spoke at the Oct. 15 meeting on the engineering and economic aspects of nuclear power. He is responsible for pilot planning activities in the research and development program, and coordinates his company's activities in the field of nuclear energy.

Lima

Allan Gunderson, chief engineer for George Gorton Machine Co., conducted a discussion on simplification of lowering costs, increasing productivity, and improving finishes by the use of pantography, manual and hydraulic duplication, and by employing special design to standard equipment. Coffee speaker was Harry Martin, principal of Lima Senior High School, whose topic was "The Gifted Student."

Indianapolis

One-hundred-twenty members attended the Oct. 2 meeting to hear Tom W. Farron, sales manager of Michigan Drill Head Co., talk on standard components in special machine design. He stressed the need for careful consideration of chip removal and lubrication problems in special machinery. His talk was followed by a narrated motion picture of a transfer machine used in making an air-conditioned compressor housing.

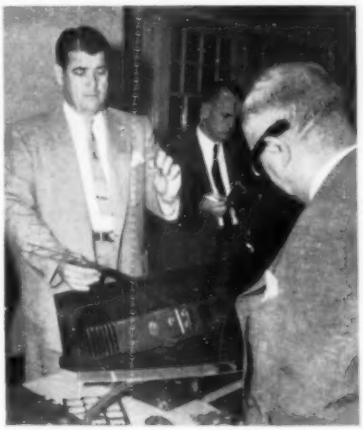
Hamilton

"Precision Boring" was the title of a talk given at the Oct. 10 meeting by Allen Sweeney, chief engineer of the Microbore Div. of DeVlieg Machine Co. Sweeney stressed the importance of three requirements in boring accurately: a machine tool, a cutting tool system, and a method for producing the proper cutting edge on a tool.

MADISON—Examining the new DoAll Co. display, "The Story of the Cutting Edge," are (left to right) Ed Kaiser, vice president of Giddings & Lewis, Fond du Lac, Wis., and national public relations committeeman; M. D. Timmeke, chairman of the Rock River Valley chapter of ASME; and Layton Wilkie, chairman of the board of The DoAll Co., Des Plaines, Ill. Sixty-five members of DoAll attended the world premiere of the new display at Madison chapter's Sept. 25 meeting. A total of 250 members and guests were present, including visitors from the University of Wisconsin Engineering Institute and ASME members. *—John C. Weston*

Evansville

Seventy-three persons attended the Oct. 13 joint meeting with Evansville-Owensboro chapter of the American Society of Quality Control to hear C. G. Schelly, managing director of the Wilkie Foundation, tell "The Story of the Cutting Edge."



LEHIGH VALLEY—Donald Oberg, president of Oberg Mfg. Co., displays sample of scrap skeletons during his talk on carbide dies at the Sept. 19 technical meeting. The 76 members present also held a special election for four officers. Chosen were Sam Kuba as chairman, Bruce Schaller as first vice chairman, Carl Occelletto, second vice chairman, and Arthur Beltz as secretary. *—Robert Hudson*

Oakland County

Devon Gables was the scene of the Oct. 16 meeting, where members and guests heard a talk on "Surface Finish" by Douglas T. Peden, vice president in charge of research for Micromatic Hone Corp. Following his talk, the movie "Progress in Precision" was shown on the application of honing of various parts.

Ann Arbor Area

James Carman, assistant general manager for Hoover Ball & Bearing Co., was the speaker at the plant tour of his company on Oct. 15, which 140 members attended. The five-month-old plant covers 200,000 square feet of manufacturing and office space. Its average yearly production is 170,000,000 chrome steel balls, 800,000,000 carbon steel balls, plus smaller amounts of stainless, brass, bronze, monel and boron.

Santa Ana Valley

Eric G. Gabbey, managing director of O-Vee Spring Gages, Ltd., London, England, and owner of O-Vee Gauge Co., Los Angeles, was the speaker at the regular monthly meeting Oct. 7. Gabbey conducted a discussion, aided by slides, on the errors in manufacturing of screw threads and their acceptance or rejection by means of different type gages. A film, "Osaka," donated by the consulate of Japan, was shown.

chips and chatter

ROCHESTER—Juergen Mattke, a fourth-year student at Rochester Institute of Technology, accepts an ASTE international scholarship award from Prof. Albert Payne, president of Mohawk Technical Institute, during Rochester's Scholarship and Educational Night.
—Walter F. Hauser

Lansing

Fifty-one members were present at the Oct. 13 technical meeting to hear C. A. Barrett, owner of Grand Valley Machine and Tool Co. and Die-Draulic, Inc., explain the die-draulic grip as a hydraulic system designed to improve the quality of stamping.

St. Louis

The Oct. 2 meeting drew 225 members and guests for the annual suppliers night. Thirty-five exhibitors displayed machinery, tools and tooling materials.

Binghamton

There were 400 members and guests present Oct. 7 at the joint tour with Elmira chapter of National Cash Register plant. R. G. Fowler, factory manager, described the new NCR plant located at Ithaca, N. Y., known as the Adding Machine Div. After dinner the visitors saw all machining and assembly areas and equipment in operation.

Fort Wayne

W. S. Holloway, development engineer for Madison Industries, was the speaker at the Oct. 8 dinner meeting on "Modern Gun Drilling Application." He covered the history of deep-hole production, gun drilling application, speeds, feeds, coolants and setup requirements.

members in the NEWS

W. G. Dahl

R. A. Wilson

W. G. Dahl, member of Springfield, Mass., chapter and formerly general manager of Latrobe Steel Co., has been appointed vice president of sales, to be located at the company's main office and plant in Latrobe, Pa.

Rene D. Wasserman of Greater New York chapter, and president of Eutectic Welding Alloys Corp., has been appointed welding industry chairman of the U. S. Committee for the United Nations, a nonpartisan national organization which disseminates information and facts about the United Nations, and also promotes observance of UN Day.

Pangborn Corp., Hagerstown, Md., has announced the appointment of **John A. Mahoney,** Greater Lancaster member, as sales engineer. Mahoney will be headquartered at the Philadelphia district office, Jenkintown, Pa. He was previously associated with Reeves Pulley Co. as a sales engineer.

Capewell Mfg. Co., Hartford, Conn., announced the appointment of **Royal A. Wilson,** member of Detroit chapter, as Michigan district manager, including Toledo, Ohio.

The appointment of **Joseph F. Wrobel** as sales manager of the F. Jos. Lamb Co. has been announced. Wrobel, who joined the Lamb Co. in 1955, has had more than 16 years' experience in the machine tool industry, having held positions in engineering, manufacturing, service and sales. He is vice chairman of Detroit chapter.

George Stern, member of Greater New York and a specialist in high-temperature treatment of metals and in powder metallurgy, has joined Nuclear Development Corp. of America as manager of the materials department. Stern is the author of a dozen technical papers in the metals field and a coauthor of the book "Powder Metallurgy—Its Physics and Production."

Chester J. Taylor and his brother, **George T. Taylor** of South Bend chapter, who have been with Norton Co. as abrasive engineers since 1912, have retired. **John W. McCue,** Indianapolis, has been appointed to succeed Chester in the Indianapolis area, and **David B. Foy,** also a former field engineer in the same office, will succeed George in the South Bend, Ind., area.

J. F. Wrobel

J. A. Gallaher

John A. Gallaher, member of Chicago chapter, has been appointed western sales manager of Haynes Stellite Co. division of Union Carbide Corp.

Walter K. Bailey, Cleveland, president of The Warner & Swasey Co., was named a member of the Case Institute of Technology Board of Trustees. Bailey joined Warner & Swasey as a special apprentice after his graduation from Oberlin College in 1919, moving up through the ranks as Northern Ohio district manager, service manager, sales manager, vice president in charge of sales and, in 1947, was made vice president in charge of manufacturing.

Keith R. Tracy, charter member of Macomb County chapter, has been appointed sales manager of Modern Body Engineering Corp. Tracy comes to this position from Jarecki Corp. Tool and Die Div., Grand Rapids, and prior to this he was affiliated for 17 years with A. O. Smith Corp., Milwaukee.

CHAPTER MEETINGS

PLACE	Dec.	SPEAKER	SUBJECT
Boston. New England Mutual Hall.	11	**Dr. Ivan Getting,** Raytheon Mfg. Co.	Rocket Progress U.S.A.
Calumet Area. Phil Smidt & Son Restaurant. 6:30 pm	16	**Ross S. Robinson,** Standard Oil Co. of Ind.	Basic Principles of Cutting Fluids and Application in Today's Plants
Catskill Region. Kingston Hotel. 7 pm, dinner; 8:15, technical meeting.	10	**W. S. Wagner,** E. W. Bliss Co.	The Working of Metals in Press Operations
Cedar Rapids. Square D Plant. 6:30 pm, dinner; 7:30, technical meeting.	4		Plant tour—ASTE members only
Cincinnati. Engineering Society Headquarters. 8 pm. Dinner 6:30	9	**Richard Halverstadt,** General Electric Co.	Machining of High-Temperature Alloys for Missile Hardware
Dayton. Miami Hotel. 6:30 pm	6		Formal dinner dance
Des Moines. Golf & Country Club. 8 pm	10	**Robert Stone,** Ransburg Electro-Coating Corp.	Electro Coating of Materials
Detroit. Latin Quarter. 7 pm	11		Christmas stag party (reservations)
Evansville. Hotel McCurdy. Dinner	8		Annual ladies night
Golden Gate. Lemington Hotel, Oakland. 8 pm	5		Christmas party
Grand River Valley. Kitchener Waterloo Collegiate Auditorium. 8 pm	4	**Dr. W. C. Winegard,** University of Toronto	Welding and Fundamentals of Metallurgy. Joint meeting with Engineering Institute of Canada and Canadian Welding Society
Hamilton District. Fischer's Hotel. 6:30 pm	12	**Thad C. Hilbert,** Cincinnati Milling & Grinding Co.	Production Milling
Hartford. Pratt & Whitney Co. Men's Club Bldg. 7 pm	1	**Herbert F. Goodwin,** Professor, M.I.T.	Work Simplification
Indianapolis. Antlers Hotel. 6:30 pm	13		Ladies night and Christmas party
Lansing. Stroh Brewing Co. Evening	12		Bus trip—plant visit
Little Rhody. Johnsons Hummocks Restaurant. 7:30 pm	6		Christmas party, ladies night
Long Island. Grumman Aircraft Corp., Bethpage. Dinner, 7 pm	8	Representative of Grumman Corp. and **Ralph Donnel,** test pilot	Plant tour (Citizenship required)
Louisville. Elks Club. 6:30 pm, dinner	13		Ladies night
Madison.	6		Ladies night
Merrimack Valley. Andover Country Club. 6:45 pm	4	**Dr. Albert P. Little,** M.I.T.	New Approach to High School Science Teaching.
Muncie. K of C.	6		Christmas party
Muskegon. Doo Drop Inn. 6 pm	9	Representative of Dodge Mfg. Corp.	Power Transmission
New Haven. Sanford Barn East, Hanford, Conn. 6:30 pm	12		Christmas party
Niagara District. Atlanta Club. 6:30 pm	4	**J. Lewis,** Tocco Div., The Ohio Crankshaft Co.	Induction Heating and Its Applications
Northern Massachusetts. Union Twist Drill Recreational Hall, Athol. 7 pm	16	**Robert Hook,** Warner Swasey Co.	Radioactive Carbides in Metal-Cutting Research
Northwestern Pennsylvania. American Legion Home. Dinner, 6:30; technical session, 7:30	4	**Robert McGee,** Jones & Laughlin Steel Corp.	Steel Manufacture
Oregon State College. Memorial Union Bldg., Oregon State College, 7:30 pm	12	**Gene Asai,** Physical Metallurgy Research, Bureau of Mines	Chromium, Development and Application
Pittsburgh. Church Hill Valley Country Club. 7 pm	12		Christmas party
Portland (Ore.). Three Star Restaurant. 7:30 pm	19		Christmas party
Racine. Dania Hall. 6:30 pm	1	**Paul Harrington,** Dow Chemical Co. **James M. Hall,** Fullerton Steel & Wire Co.	Magnesium Progress
Rochester. Barnard Exempt Firemen's Club. 6:30 pm	1	**Robert McKee,** R. K. LeBlond Co.	Science and Application of Metal-Cutting
San Fernando Valley. Hody's Restaurant. 7 pm	7	**George H. Fox, Jr.,** Chem-Mill Corp., Div. of Turco Products	Machining Metal by a Controlled Chemical Reaction
Santa Ana Valley. The Palms Restaurant. 7 pm	2	**L. G. Granstedt,** Convair Astronautics Div. General Dynamics Corp.	Tooling the Atlas
Schuylkill Valley. Berkshire Hotel. 8 pm	9	**Mr. Van Der Ploeg**	Roll Forming vs. Bending and Extruding
Springfield (Ill.) The Mill. 6:45 pm	2	**Donald Hardin,** The Texas Co.	Application and Background Studies of Hydraulic Oils
St. Louis. Sunnen Products Co. 5:30 pm	4		Plant tour
Twin States. Adnabrown Hotel.	10	**Raymond Walls,** Bendix Computer Div.	The Electronic Computer. Demonstration of digital computer at The Fellows Gear Shaper Co.
Windsor. Prince Edward Hotel. 6:30 pm	8	Representative of Rudel Machinery Co.	Cold Extrusion of Steel
Worcester. Frosheim Club, Shrewsbury. 7 pm	12		Ladies night and Christmas party

SPECIAL EVENTS

ASTE 27th Annual Meeting.
April 18-22, 1959, Schroeder Hotel, Milwaukee, Wis.

Position Wanted

TOOL STEEL SALESMAN with 10 years' experience in all facets of business, seeking opportunity in company that is still growing, where new ideas are encouraged. College-educated. Interests and activities cover broad range. For resume, write to: Box 132, News Dept. The Tool Engineer, 10700 Puritan Ave., Detroit 38, Mich.

Obituaries

Harry C. Beatty, Mid-Hudson, draftsman for DeLaval Separator Co.

Alfred E. Chandler, Merrimack Valley, design engineer for Greenerd Press Co.

William G. Dechend, Buffalo-Niagara District, engineer for Sage Equipment Co.

Hollis U. Gordon, Racine, manufacturer's agent and owner of Hollis Gordon Co.

George B. Lanman, Calumet Area, president of E. B. Lanman Co.

Earl A. Morgan, Calumet Area, owner, E. A. Morgan & Co.

Robert Witkowski, Toronto, foreman for Canadian S.K.F. Co., Ltd.

Herman J. Wolf, Monmouth, superintendent for Bendix Aviation.

BOSTON—Alfred Simon, of Raytheon Mfg. Co., demonstrates the insulating properties of plastic foam during Sept. 18 technical meeting. In addition to Simon's lecture, the 100 members and guests present also heard John Rotchford, chairman of the national standards committee, speak on what the standards committee is doing. —*C. Moody*

V-R Multiple tooling cuts at BOTH 450 and 113 s. f. p. m.

How V-R Carbide and TANTUNG® cast alloy gang up to solve cutting problems

PROBLEM: How to bore 2" I.D. at 113 SFPM while turning 8" O.D. at 450 SFPM.

SOLUTION: A V-R toolholder and throw away insert will perform perfectly on the 450 SFPM O.D. but the 113 SFPM boring speed demands the cutting qualities of V-R TANTUNG cast alloy. TANTUNG is especially engineered for speeds between carbide and High Speed Steel.

V-R Carbide and TANTUNG make a perfect tooling team to solve this and many other cutting problems. Ask your V-R Representative or write for complete information. V-R Engineers will be glad to work with you on all of your cutting problems.

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Progress in Production

PLATING TECHNIQUE AFFORDS TOP QUALITIES

Chromium is being plated directly to aluminum and its alloys because of a new process called Chrom-Lume. The technique, developed by Service Hard-Chromium Co., needs no intermediate metallic deposition of copper, nickel or zincate. Research division engineers refer to it as "3-D" because of its characteristics—direct, dense and extremely ductile. The strong adherent bond between the two metals afforded by the technique, prevents possibility of galvanic action and prevents undesirable electrolytic couples.

Dense application affords high torsional and impact load with a low coefficient of friction while oxidation is effectively reduced.

The wide measure of ductility allows improved stress absorption. In tests where severe deformations were made by inflicting sharp tool indentations, the chromium coating was shown to be ductile enough to withstand chipping, peeling, cracking or flaking. Compressive and sheering stress tests indicated a flow of the coating with the basic metal as opposed to a spalling action.

The process appears to provide a uniformity of deposition, even in deep recesses. Coating thickness does not seem to affect post grinding or lapping.

GASSING PROCESS FACILITATES MOLD MAKING

High quality castings with unusual dimensional tolerances are being turned out as a result of a process for producing molds by the CO_2 molding method. Prime economy gained from the operation is the elimination of machining.

Success of the process grows out of proper sand mix according to Swayne, Robinson & Co., which announced the development. Results of extensive tests determined proper balance of sand, binder and release agent to produce castings with excellent fidelity of detail.

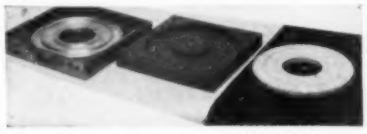
Gassing of the mold is generally efficient because curing is in a cold state. Further, it minimizes chance of dimensional change due to uneven cool in sections of varying thickness.

According to C. K. Robinson, Jr., company vice-president, the Azcast CO_2 molding process has adapted itself well to foundry operation and has provided high quality castings at a cost advantage.

SIMPLE CASTING METHOD BOOSTS SAVINGS

Ceramic tooling for operation at temperatures up to 3000 F is being produced economically by a simple casting technique using a high temperature ceramic material developed by Duramic Products, Inc.

To accomplish the job, a plastic mold is formed from an aluminum master of the finished tool. Into this negative the ceramic slurry is poured. After setting, the finished casting is heat treated at a temperature slightly above its required operating temperature. It then is ready for use.



This series shows the simple method of fabricating Duramic's Sur-Braze S-2 cast high temperature tooling.

The Sur-Braze S-2 tool illustrated was used as high temperature brazing fixture by an aircraft engine manufacturer in brazing shroud and vane assemblies. Cost for the ceramic casting was $21—an economic advantage compared to $435 for the conventional fixture used previously. The earlier fixture also was about three times heavier than the ceramic.

Low thermal expansion rate of the ceramic material assures minimum warpage and close dimensional stability.

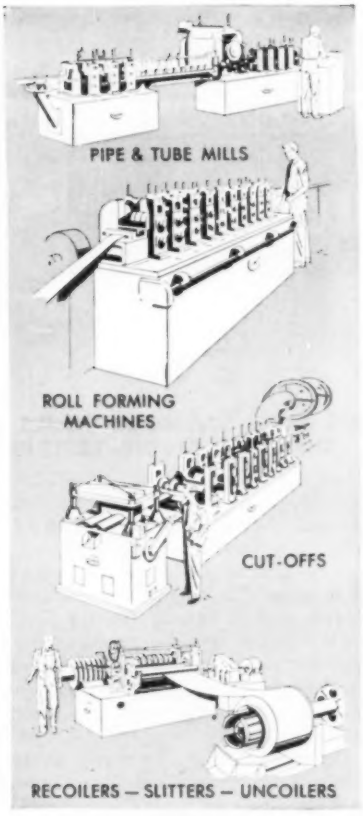
RIG FROM STANDARD TOOLS SIMPLIFIES SPRING TESTING

An ingenious adaptation of standard tools has simplified a routine job at General Electric Co. A standard off-the-shelf force measuring gage is mounted in an easy to operate test fixture—result is speed-up of a standardized functional testing of brush springs for the Kinamatic line of motor-generators. The Hunter Spring gage is used to check the load developed by the Neg'ator constant-force brush springs at both initial and final lengths.

A yoke secures the force gage to the fixture base. A simulated carbon brush extends from the gage's compression head. The brush spring to be tested is mounted on a sliding carriage, and movement of the carriage, while the spring is in contact with the "brush," deflects the spring. Relative movement between the sliding carriage and the simulated brush, which equals spring deflection, is measured on an adjustable linear scale mounted on the carriage.

In performing the test the patented brush spring assembly is inserted in the sliding carriage, and the carriage is advanced until initial contact is made between the spring coil and the bevelled surface of the brush. Contact is indicated by the first slight movement of the gage dial and establishes the point of zero spring deflection on the linear scale, graduated in 64ths. Further advance of the carriage extends the spring until maximum deflection is reached, and spring load is read on the gage dial. To complete the test, the sliding carriage is backed off to the minimum operating deflection and the load is again read directly.

All sizes of brush springs for the complete line of Kinamatic motors can be tested in the one fixture. Because dimensions of the different springs vary, the carriage mount is adjustable to assure proper location of the spring with respect to the simulated brush attachment. An insert (made from the same carbon material used for the brushes) in the bevelled head of the steel brush



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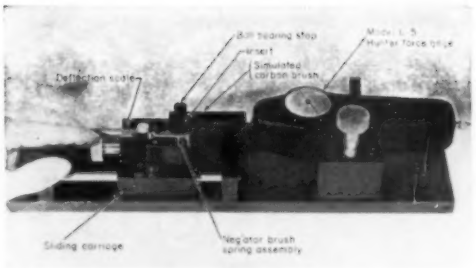


Force exerted by the brush spring is read directly on the gage dial. Knob at left advances or backs off the carriage; knob at right adjusts gage height. The ball bearing prevents lateral movement of the brush without imposing friction on longitudinal movement.

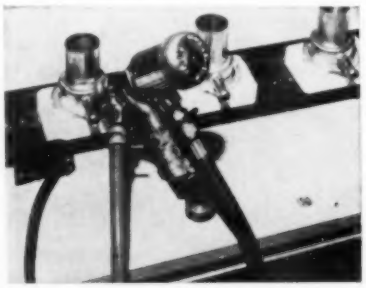
provides the same friction between spring and brush as in operation. Height of the gage above the fixture base also is adjustable so that spring force is always applied along the gage axis. A pin-mounted ball bearing stop prevents lateral deflection of the brush without frictional resistance to longitudinal brush movement which would introduce error into the force readings.

Force exerted by each constant-force brush spring must be the same, within tolerance limits, at both initial and final deflections. Brush springs for the Kinamatic line vary in load from approximately 1 to 5 lb and their total deflections range from approximately ½ to 1½ in.

SILVER BRAZING PROCESS NETS ECONOMY

High speed, economical production silver brazing of component parts is possible using a process developed by Fusion Engineering. The technique automatically preplaces brazing alloy and flux onto the parts while on the production line, and automatic heating devices complete the operation. Important is the constant quality of the soldered joint.

For high-production shops, equipment can be adapted to present production facilities with a minimum of process engineering. In an adaptation of the method to his production line, one manufacturer of fittings for internal combustion engines reported more than a five thousand dollars annual saving. Two operators had been required to apply silver solder rings and flux. In this case one operator, which cost the company four thousand dollars per year, was replaced with automatic equipment costing four hundred dollars. Material savings averaged 10 percent and reject parts dropped to less than ½ percent.



Automatic application of brazing alloy and flux plus automatic heating speeds the operation.

UNCONVENTIONAL METHODS SOLVE MACHINING PROBLEM

How to machine a 17-4-PH stainless-steel sliding side door closing sleeve temporarily stumped tooling and carbide engineers at Otis Engineering Co. Engineers brought solution to the problem by turning to unorthodox practices for machining such materials. Negative rake angles now are used on the turning tools instead of positive rakes; soluble oil is used instead of sulphochlorinated active sulfur-based coolants, and cutting speeds three times those normally recommended are successfully used for both rough and finish turning. Turning is done with a single, relatively small throwaway-insert type toolholder, having a 45-deg lead angle, primarily designed for chamfering operations.

Complications in this stainless turning job were extreme cutting pressures, intense heat at the tool-chip interface, abrasive edge wear and cratering caused by the high tensile extremely hard steel, and chip breaking or control problems. Work is done on a 16-in. Lodge & Shipley 20-hp tracer lathe.

Excessive carbide wear and cratering seemed to indicate need for a sulfur-based oil coolant, but engineers successfully attacked the heat problem by applying a soluble coolant so that it flooded the cutting edge.

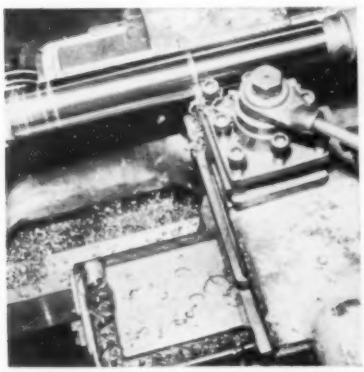
A series of machinability tests, in which engineers of the Wesson Co. assisted, were run with a standard negative-rake throwaway insert toolholder. As a result of these tests, Wessonmetal-26 carbide, having high red hardness, wear and crater resistance, and compressive strength, was specified for the job and results in five times the tool life. Combination of soluble-oil coolant and this grade of carbide effectively reduced

cratering and avoided the carbide pressure cracks that previously had developed.

Engineers then started increasing speeds and feeds until an optimum life of 80 sleeves per insert was achieved at 600 fpm and a feed of 0.012 ipr. Depths of cut of 7/32 in. from the rough and 1/32 in. for finishing are unchanged.

Originally, the job had been running at 435 fpm at a feed of 0.010 ipr. Even with the soluble coolant, none of the former tooling could produce more than two sleeves per edge. At higher speeds, these other tools were unable to complete the second pass.

The 7-deg negative-rake holder was able to withstand cutting pressures well



A finish of 63 microinches, rms, is produced on these 17-4-PH stainless-steel sleeves in spite of the use of partially ground utility inserts in a negative-rake holder.

and its geometry provides complete chip control on both rough and finish cuts. This is done with a quickly adjustable chip breaker-clamp that is reset by the operator between the roughing and finishing cuts. After a single roughing cut on one of the 13-in. long sleeves the partially ground throwaway presents an edge having a honed effect. This fact, coupled with the 3/64-in. radius, high surface speed and 0.005-in. feed, accounts for the quality of the finishes obtained. There is no evidence of rubbing.

Net result of these unorthodox methods has been a substantial increase in output per unit of time. Sleeve output per insert has been increased approximately 400 percent with floor-to-floor time reduced 65 percent. The lathe department is now able to meet production requirements and has at the same time effected significant cost reductions. Tool cost to completely rough and finish one closing sleeve is now 0.08c as against a former cost of 0.17c.

Success of the technique emphasizes the advantages of approaching such machining on basis of specific problems.

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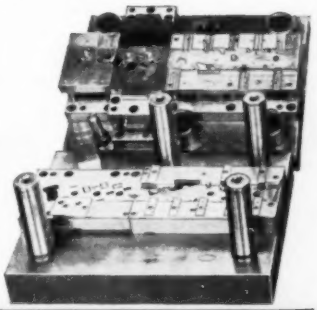
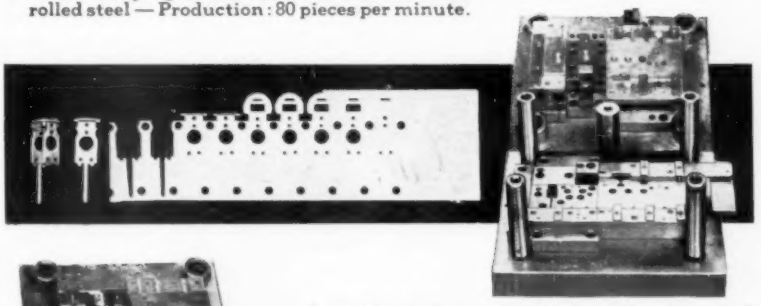
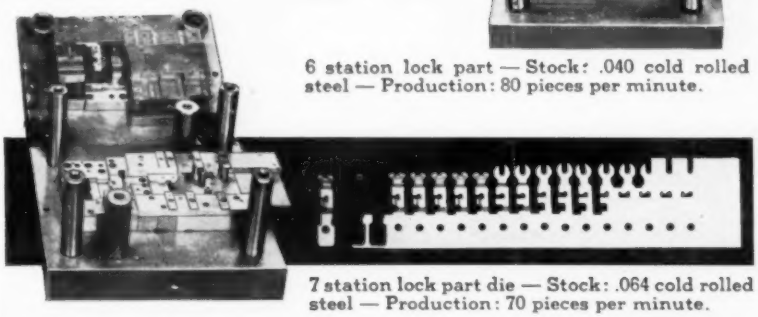


8 station progressive die — Stock: .040 cold rolled steel — Production: 80 pieces per minute.



6 station lock part — Stock: .040 cold rolled steel — Production: 80 pieces per minute.



7 station lock part die — Stock: .064 cold rolled steel — Production: 70 pieces per minute.

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Eliminate Stock Pushers...
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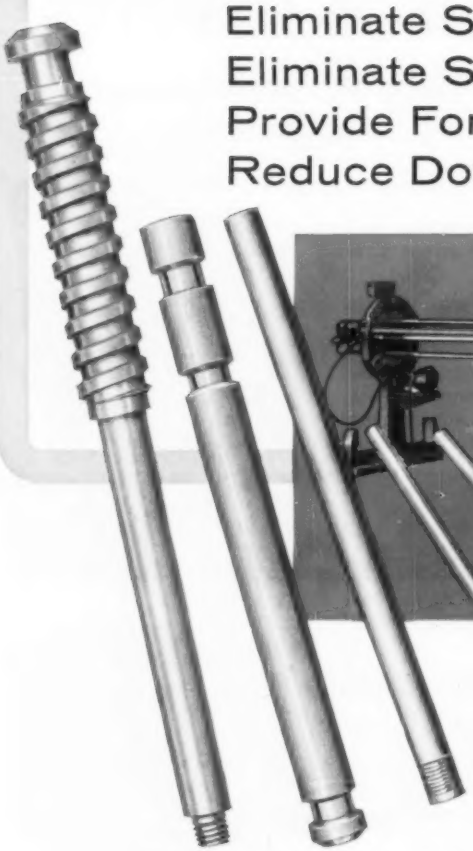

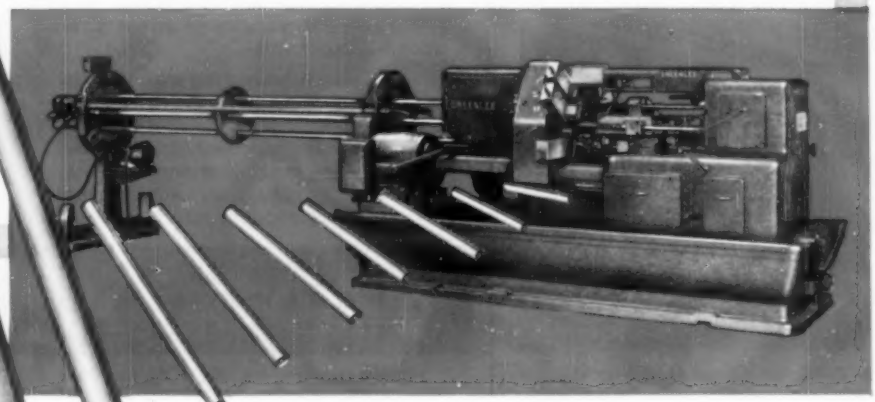

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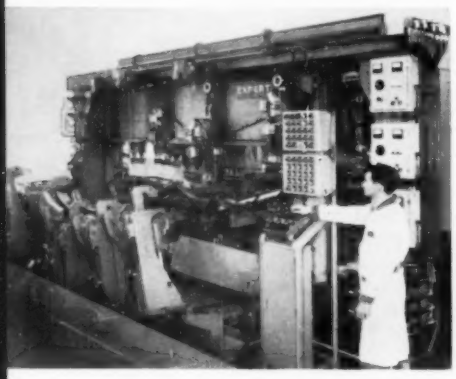
TOOLS of today

Tape-Controlled Welding System

This magnetic tape tracer welding system permits metal parts with untrimmed, out-of-tolerance, straight line or contour weld line edges to be joined in a continuous automated welding operation. Self-powered welding heads automatically follow any type welding contour with a high degree of accuracy. The system is so designed that error between the actual and design weld line is automatically corrected.



A mechanical probe, which initially detects the error for correction, is positioned a few inches ahead of the welding head to avoid weld splatter deposits on the probe which would hinder its operation.

A loop of magnetic tape is used to eliminate rewinding operations. An erasing head located behind the reading head erases the signal after it has been used. The tape can be used many thousand times before replacement is required.

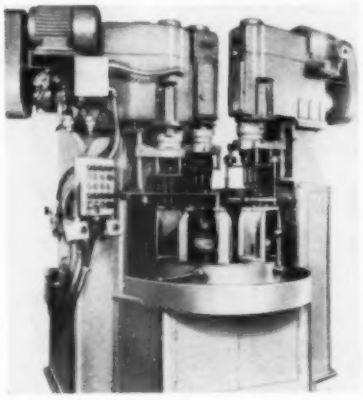
Current machines use the CO_2 arc-welding process; however, the basic tracer system is equally adaptable to any other arc-welding process.

The workholding platen in the welding station contains a family of air-operated clamps that provide nominally continuous side clamping pressure below the weld line along the entire length of the part. These bronze clamp jaws are also adjustable to compensate for springback of the part and are also screw adjustable to compensate for any wear conditions.

Expert Welding Machine Div., Expert Die & Tool Co., 17144 Mt. Elliott Ave., Detroit 12, Mich. **T-12-1**

Tapping Machine

Model 10E-1125 tapping machine drills, countersinks and taps a variety of flanged valve bodies. The three-head machine, provided with 7½ hp standard head units, has four-spindle adjustable heads and five-division index. Head units are provided with six-speed transmission, hydraulically operated adjustable feed, rapid advance and adjustable time delay at bottom of stroke. It handles a large range of flanged bodies with different diameter of drills, countersinks and taps on a variety of bolt circles.

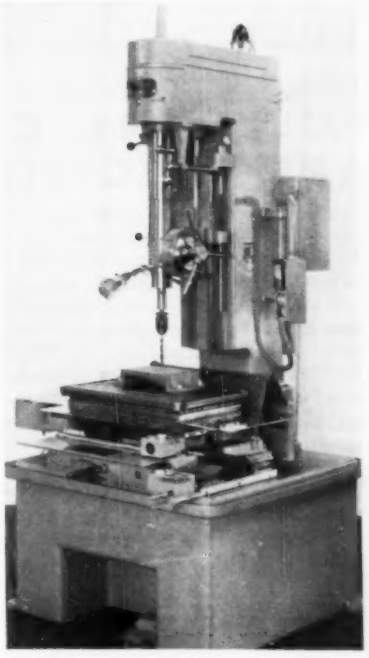


Kaufman Mfg. Co., Manitowoc, Wis. **T-12-2**

Layout Machine

Efficient performance of such layout operations as center drilling and drilling and reaming in parts which do not require jig boring tolerances is possible with the No. 2 layout machine. It can be supplied with hand operated screw type tables, semiautomatic tables using gage blocks or spacer bars, or tables automatically programmed by tape or card.

The spindle is fully counterbalanced and upward travel is limited by a movable stop. The machine has an 8:1 speed ratio in direct drive and back gears of 4:1. Use of different speed motors assures complete speed range. A semiautomatic power feed allows automatic power feeding of the tool. Upper portion of the spindle sleeve and spindle are entirely enclosed by a tele-



scopic guard. There are four standard feed rates of 0.0015, 0.0025, 0.004 and 0.0075 in. in direct drive and four additional heavier feed rates of 0.006, 0.010, 0.016 and 0.030 in. are provided in back gear drive. An electrical speed changing device has infinitely adjustable spindle speeds achieved through pushbuttons located on a pendant control that swivels on side arm. Accurate spindle speed is indicated on a tachometer in the same pendant box.

Rated capacity of the machine is 1 in. in cast iron; ⅞ in. in mild steel. Spindle speeds with a 900-rpm motor are variable from 340 to 2700 rpm in direct drive and 85 to 675 rpm in back gear drive. With 1200-rpm motor, spindle speeds are variable 450 to 3600 rpm in direct drive, and from 112 to 900 rpm in back gear drive.

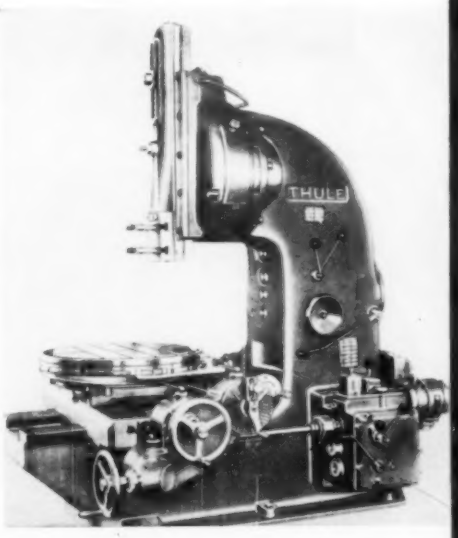
Edlund Machinery Co., 48 Huntington St., Cortland, N. Y. **T-12-3**

USE READER SERVICE CARD ON PAGE 135 TO REQUEST ADDITIONAL TOOLS OF TODAY INFORMATION

Vertical Shaper

The Thule Model ST-12 in. vertical shaper machines parts having regular or irregular, internal or external contours at one setup. Column and base of this heavy-duty machine are cast integral for rigidity and to prevent vibration. Six ram speeds are available from 15 to 75 strokes per minute.

It affords fast ram return at twice cutting speed; ram brake; longitudinal.



transverse and rotary movements by either hand or power feed; and power rapid traverse in three directions. The ram swivels 12 deg in vertical plane.

Standard equipment includes 24-in. diameter built-in rotary table arranged for both crank indexing and direct indexing, automatic pressure lubrication and V-belt drive from 5 hp main motor.

Austin Industrial Corp., 76 Mamaroneck Ave., White Plains, N. Y. **T-12-4**

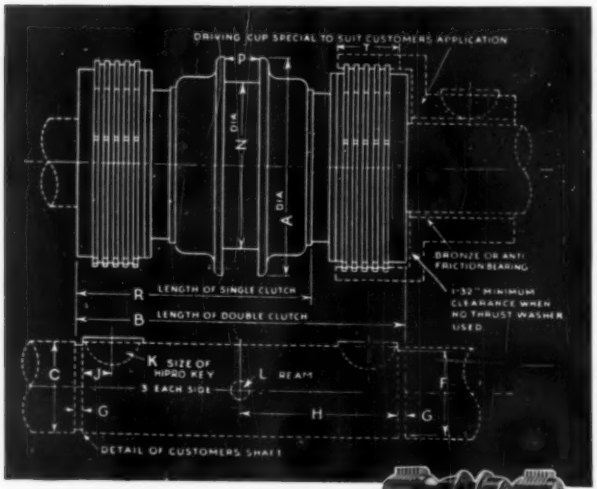
Tap Holder

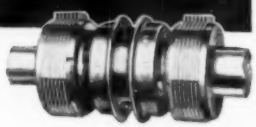
Compact Bilz tap holder, made in West Germany, combines precise ball bearing length compensation, nonfriction torque and axially parallel float. Tap sizes or taps can be changed quickly without tools.

Because of the length compensation features, precision threads are possible regardless of the type or condition of the machine used. There is no shaving or scuffing of thread flank angles, and ordinarily no changes of lead screws when tap sizes are changed. Axially parallel floating action permits the tap to compensate for all ordinary differences in alignment.

Preset adjustable torque control is built into the tap adaptor. Taps can be bottomed without danger of breakage.

ROCKFORD





Multiple-Disc • Single or Double • Oil or Dry Type

PULLMORE CLUTCHES ARE PRECISION BUILT

Precision machining and grinding, proper hardening and the symmetrical contours of PULLMORE Multiple-Disc CLUTCHES insure perfect balance and smooth operation at both high and low speeds. Because of this close-tolerance construction and compact design the powerful pull of PULLMORE CLUTCHES is not affected by centrifugal force or the direction of rotation. They handle loads of greater capacity when operated at high speeds.

Send for This Handy Bulletin

Shows typical installations of ROCKFORD CLUTCHES and POWER-TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

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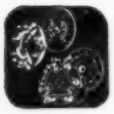


Small Spring Loaded

Heavy Duty Spring Loaded

Oil or Dry Multiple Disc

Heavy Duty Over Center

Power Take-Offs

Speed Reducers

CLUTCHES

FOR FURTHER INFORMATION, USE READER SERVICE CARD; INDICATE A-12-114

Permissible dullness of taps can be preset, and constant torque settings are maintained regardless of slippage. Bilz holders have a range from No. 0 machine screw size up to 2½ in.

A compensating holder is available

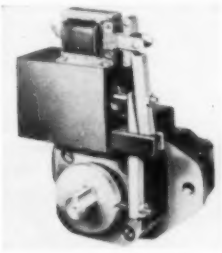
with a tap capacity up to ½ in. with a diameter of only ¾ in. The holder has no reverse and must be used with a reversible spindle.

T. M. Smith Tool Co., 14644 Puritan Ave., Detroit 27, Mich. **T-12-5**

Fluid Powered Drive

A compact fluid powered one revolution drive produces smooth, quiet, instant high torque through fluid motor, planetary reduction and solenoid actuated starter. A built-in valve compensates during movement and unload while stationary.

Rapid, smooth acceleration and deceleration, as well as positive stop are



provided by a cam and adjustable finger lever arrangement. The unit, which is available in a range of output torque capacities and speeds, may also be arranged for manual or mechanical starting, or multirevolution operation.

Constant-Flo Div., John S. Barnes Corp., 301 S. Water St., Rockford, Ill. **T-12-6**

Cutoff Blades

Grinding technique used for Mo-Max T-shaped cutoff blades assures high accuracy in all dimensions. Head and body are always equidistant from the center line thus providing complete interchangeability and saving setup time.

Top of each blade is ground with a radius, so that chips are crimped. As a result chips are narrower than the blade itself to permit a cool running tool, minimum scoring on the sides of the cut and easy application of coolant.

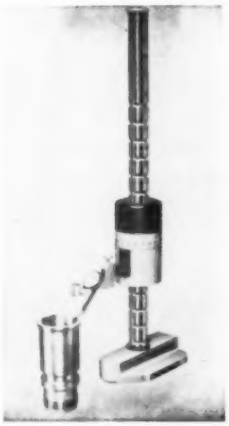
The blades are available in two high-speed steels: Mo-Max and Mo-Max cobalt for difficult jobs where a high degree of red hardness is required.

The Cleveland Twist Drill Co., 1242 E. 49th St., Cleveland 14, Ohio. **T-12-7**

Height Gages

Readings to ten thousandths can be made on this Height Master gage that features an easily read micrometer scale.

The unit, which ranges up to 120 in. in height, function as both height check-



ing and height measuring instrument. Accuracies are assured within fifty millionths of an inch.

Dial indicator, offset scribes and other accessories are supplied as standard equipment.

The Challenge Machinery Co., Grand Haven, Mich. **T-12-8**

Hardness Tester

Developed for high-production Brinell hardness testing where location of the test must be accurate, this machine determines workpiece position before it can operate. A precision limit switch in the table fixture must be depressed by the part before the knee-actuated cycle-switch becomes energized. Cycle time is two seconds.

Gaertner Toolmakers' Microscope used to measure typical piece part. Co-ordinate range 4" x 2".

Precise measurement to 0.0001" and 1 min. of arc

Gaertner Toolmakers' Microscope

Here is a reliable, easy-to-use microscope for precise measurement of piece parts, tools, dies, thread gages, templates, jigs, fixtures, etc. Ideally suited for making a wide variety of precision measurements and is especially valuable in reducing rejects in production work.

With the Gaertner Toolmakers' Microscope you make direct, non-destructive measurements — no contact, no distortion, images are sharp and clear. It is a basic measuring instrument for inspection depts., gage labs, tool and die and model shops, industrial and research labs.

The Gaertner Toolmakers' Microscope has been proven in use by U. S. Government Gage Laboratories, and by prime contractors and their subcontractors. With all parties using the same measuring instrument, inspection procedures are co-ordinated and disagreements and rejects minimized.

Features that help you get
HIGH SETTING AND REPEATING ACCURACY

- Low, compact built-in rotary stage reads to 1 minute of arc throughout 360° range.
- Minimum overhang of stages.
- Full 2" precision-lapped lead screws with correction device.
- Straightforward, direct, uncomplicated optical system.

Features that assure you of
EASY, CONVENIENT OPERATION

- Independently rotatable cross hairs in protractor ocular speed up measurements, simplify measuring procedure.
- Convenient location of ocular eyepieces for ease of reading.
- Built-in transformer and plugs for all illuminators.

Modifications and accessories to
MEET YOUR EXACT REQUIREMENTS

- Thread and radius templates, camera and spotting attachments, fine motion focus, variable magnification available.
- If you have a special measuring problem, our staff of representatives will be happy to consult with you. The service and engineering facilities of the manufacturer are always immediately available to help you.

Write for Bulletin 147-56

Designed and manufactured by

The Gaertner Scientific Corporation

1241 Wrightwood Ave., Chicago 14, Ill.
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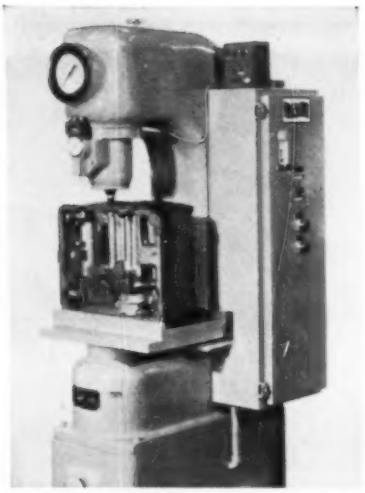
INDICATE A-12-115



A system of colored lights indicates relative hardness of the part under test: whether too hard, too soft, or acceptable. The machine can distinguish a difference in diameter of impression of 0.1 mm. Limits for the Brinell range to be indicated by the lights are selected by using pieces of known hardness.

After the limit switch and cycle switch have been actuated, the tester applies full hydraulically applied load (which is adjustable), signals the hardness, and withdraws the penetrator automatically. Penetrator ram has a maximum travel of 1 in. A gage on the front of the machine is periodically used to check the applied load.

Steel City Testing Machines, Inc., 8817 Lyndon Ave., Detroit 38, Mich.

T-12-9

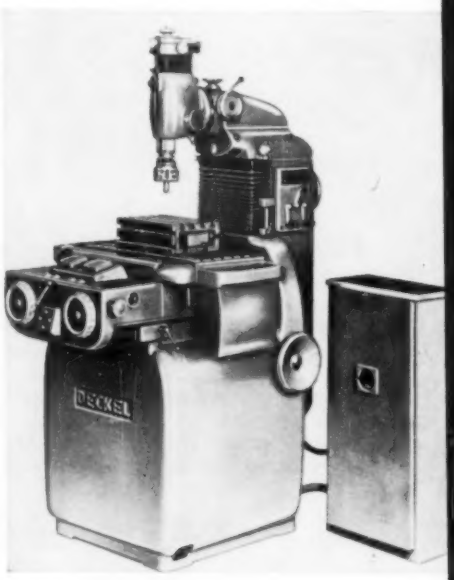
Multipurpose Machines—Interchangeable Heads

Deckel LK Series of machine tools is designed for interchangeability of jig boring, jig grinding and optical projection measuring heads on one base; direct numerical readings of settings; and built-in compensation for thermal expansion.

Change from one head to another takes only minutes. Individual heads are mounted on a rigid bracket supported on a heavy base. Any of the three types can be used as a single-purpose machine, or all three as a universal machine with but one base.

Table measurements can be read directly in numbers to 0.0001 in. without conversions or interpolations. Actual positioning accuracy falls within 0.00012 in. The range of coordinate readings for the jig boring and jig grinding machines is 15.75 x 10 in. Worktable area for these machines is 25.6 x 11.8 in.

Besides built-in compensation for thermal expansion, additional thermal



stability is provided by a special air duct that dissipates heat generated from the drive motor and by an extra large amount of oil to maintain practically constant gearbox temperature.

Boring spindle of the jig boring machine has 20 different speeds from 40 to 3150 rpm and six different feed rates either up or down. Maximum work height is 24 in. On the jig grinding machine, the grinding spindle has 12 planetary motion speeds from 40 to 500 rpm and infinitely adjustable grinding speeds from 15,000 to 60,000 rpm. All types of grinding can be performed.

The measuring machine will perform

STILL ANOTHER LODDING FIRST!

Lodding, Inc. announces a completely automatic clamp (patent pending). This new Lodding production meets the need of the metalworking industry for a compact, automatic and heavy-duty clamp. Air operated and cam locked to hold clamp locked in any event of air failure. Note the compactness (the air cylinder is under the clamp). Delivers ten times line pressure. All wearing parts heat treated. Overall dimensions are 3" wide, 3⅝" high and 8¼" long.

LODDING, INC.
WORCESTER 1, MASS.

Goodwin-Snader Co.
6814 S. Western Ave.
Los Angeles 47, Calif.
PLeasant 3-1553

Atlanta, Ga. Warehouse
54 11th St., N.E.
TRinity 5-7065

Bagby Engineering Co.
1047 Forest Ave.
Evanston, Ill.
AMbassador 2-2273

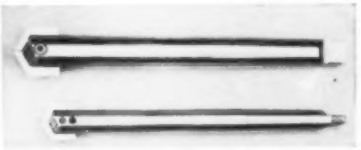
FOR FURTHER INFORMATION, USE READER SERVICE CARD; INDICATE A-12-116

all types of measuring operations. It projects images on a screen 7⅞ in. in diameter to a magnification of 10 or 20X. Useful measuring table data area is 18.7 x 10.6 in.

Cosa Corp., 405 Lexington Ave., New York 17, N. Y. **T-12-10**

Cutting Tool

With this twin point drilling, boring and end milling tool, it is possible to drill a hole in metal from a solid and set it to proper size. Two movable blades are designed so their combined point is the center of arcs of two ball-bearing grooves in the adapter. Two holes in the blades retain bearings which control the blades as they are swung in and out to cut different diameters. This leaves the drill point always on center. Adjustment or blade change



is quick and simple. Body of the tool is one-piece construction.

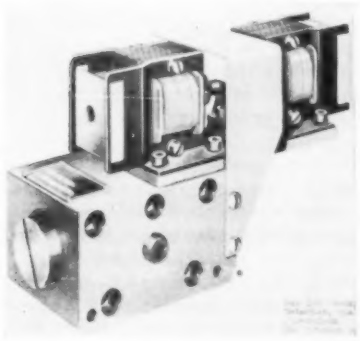
The tool, called the Trocki ball-bearing adjustable drill, is available in four sizes, ranging from ⅞ to 2^{3}⁄$_{32}$ in. It can be used in regular or radial drill presses, lathes, screw machines, turret lathes, vertical machines or jig borers.

Erie Precision Products Co., 1346 E. 12th St., Erie, Pa. **T-12-11**

USE READER SERVICE CARD ON PAGE 135 TO REQUEST ADDITIONAL TOOLS OF TODAY INFORMATION

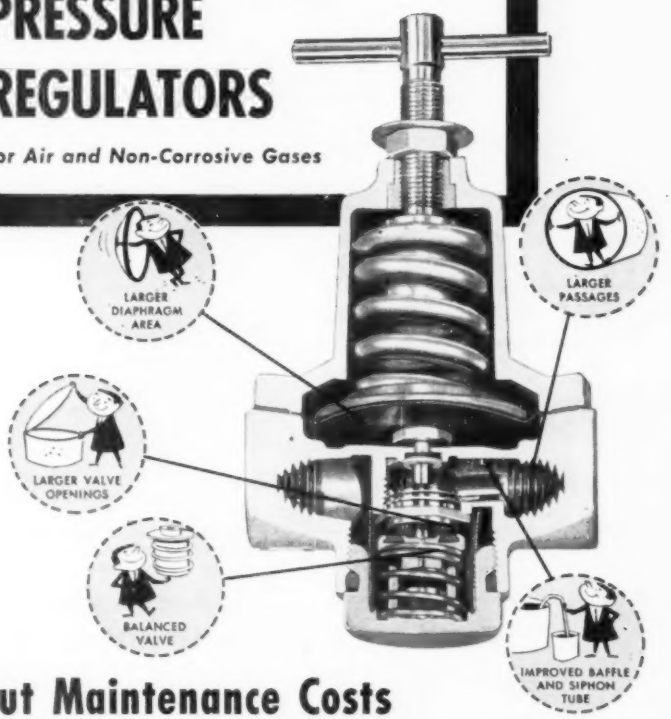
Directional Control Valve

Compact, ¼-in. four-way, two-position, detented, dual solenoid operated directional control valves have accurately machined grooves to insure positive and consistent results. These Mighty Midget continuous duty solenoids,



Reduce air costs with *Norgren* PRESSURE REGULATORS

For Air and Non-Corrosive Gases



Cut Maintenance Costs

Most air operated equipment has one pressure at which it operates most efficiently. Above that pressure, equipment wears excessively with no significant increase in output, and compressed air is wasted. Norgren Pressure Regulators reduce line pressures to the desired working pressure, produce better equipment performance and longer life, lower maintenance and compressed air costs.

Highly Accurate over a wide operating range.

Regulated Pressure Held Constant even with widely fluctuating line pressure and rapidly varying air flow.

Large Flow Capacity—a. Balanced valve construction; b. Large effective diaphragm area; c. Improved baffle and siphon performance; d. Large passages; e. Large valve openings.

Also regulators for water, oil, other liquids and steam.

For complete information, call the Norgren Representative listed in your telephone directory—or **Write for Descriptive Literature.**

If it's Norgren...It's Dependable.

C. A. NORGREN CO.

3447 SO. ELATI STREET • ENGLEWOOD, COLORADO

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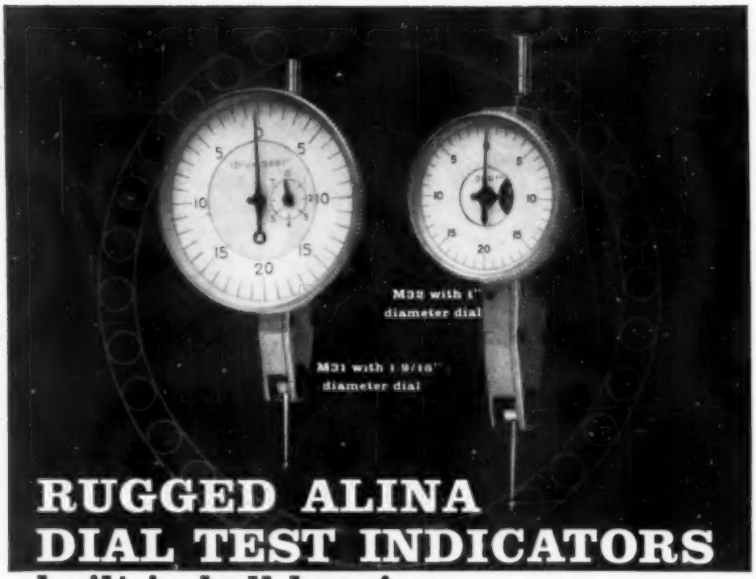


RUGGED ALINA DIAL TEST INDICATORS

built-in ball bearings

for greater sensitivity – reduced pressure – improved accuracy

- Jeweled • Shock Proof • Range .032" • Graduated .0001"
- Reading 0-20-0 • Fully reversible contact point

Available with a wide variety of rectangular or round shanks.

The instruments shown here are part of a complete line of precision DIAL TEST INDICATORS of all types — Write for brochure!

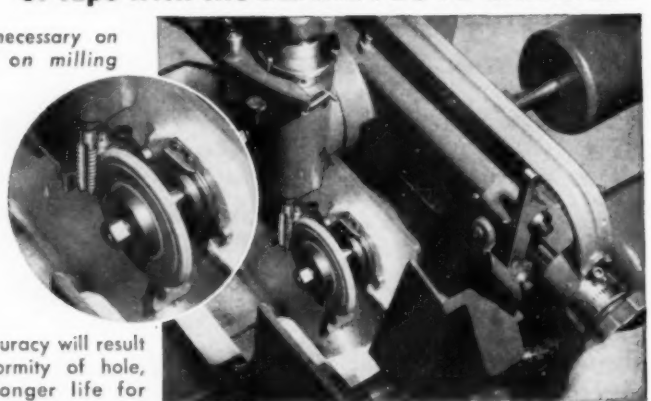
ALINA CORPORATION

122 East Second St., Mineola, L.I., N.Y.

FOR FURTHER INFORMATION, USE READER SERVICE CARD; INDICATE A-12-118-1

NOW – You can control rake or hook angle and insure accurate indexing of cutting edges* of taps with the BLAKE FLUTE GRINDER.

**Just as necessary on taps as on milling cutters.*



This accuracy will result in uniformity of hole, much longer life for your taps and a surprising savings in tap costs.

Keep it sharp — Make 1 tap do the work of 6 with The Blake Flute Grinder.

Write for bulletins on BLAKE Tap Sharpening Machines

EDWARD **BLAKE** COMPANY INC.

MANUFACTURERS OF FLUTE AND CHAMFER GRINDERS

450 CHERRY ST., WEST NEWTON 65, MASS.

Exclusive Distributors of:

Black Diamond Drill Grinders • Surface Finish Standards • Worcester Drill Grinders

FOR FURTHER INFORMATION, USE READER SERVICE CARD; INDICATE A-12-118-2

which provide smooth, quiet shifting, are particularly adaptable to remotely control direction of flow for hydraulic actuations.

Flow capacity is 3½ gpm; operating pressure is 1000 psi. They can be mounted horizontal or vertical, and are available in manifold or pipe tap styles.

John S. Barnes Corp., 301 S. Water St., Rockford, Ill. **T-12-12**

Casting Plastic

Gravity casting plastic is intended for production of light metal dies, short-run gages and similar tooling. Polyplastic B is nontoxic, nonirritating and nonadhesive, and does not present a fire hazard. The plastic is dimensionally stable and has excellent flow characteristics. Cast parts are strong, accurate and tough.

Scientific Abrasives, P. O. Box 234, Park Ridge, Ill. **T-12-13**

Tap and Die Grinding Machines

On this thread cutting tool resharpening equipment, any operation involved in the resharpening of thread cutting tools can be easily done by using different grinding attachments.

The machine is available in two models. On both, the machine base is

solid and contains the dust extractor. Model RS 2 also contains wet grinding equipment in the base. The table is movable by means of a steel band controlled by a hand lever. Side movement is limited by a central stop, adjustable by a clutch. The revolving spindle carrier is adjustable vertically and horizontally. Standard grinding wheels and mounted wheels can be used. Both machines grind the chamfer as well as the flutes, either straight or spiral.

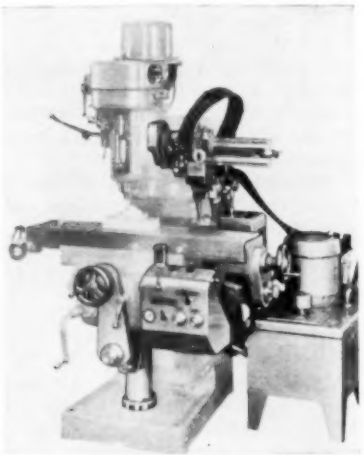
Model RS 1* is suitable for resharpening taps up to 1 3/16 in. with a maximum length of 6 in. and dies up to 4¾

in. OD. The Model RS 2 chamfers drills with a maximum diameter of 8 in and a total length of 12½ in. It can grind flutes of straight or spiral fluted taps and supply them with correct rake angle. The Model RS 2 grinds taps with a maximum diameter of 4¾ in. and a maximum length of 12½ in. Grinding spindle speeds are: 5600 and 22,000 for the RS 1; and 3800, 6000, 12,500 (22,500) for the Model RS 2.

Reime Div., P. O. Box 92, Pompton Lakes, N. J. **T-12-14**

Automatic Tracing System

A hydraulic tracer and machine tool control system identified as the Synchro-Trace system is adaptable to all makes of milling machines as a complete attachment for die sinking and mold making. With it, a mill can be used as conventional mill, with hand or power feed, or as fully automatic die sinker.



Pick feed on either cross or longitudinal feeds are infinitely adjustable from 0.002 to 0.250 in. Cutter feed is uniform regardless of angle or shape of pattern, and vertical walls are easily duplicated. Stylus oversize remains constant, regardless of feed rate.

Dept. SM, True-Trace Sales Corp., P. O. Box 3307, El Monte, Calif. **T-12-15**

Metal Coating

A metal coating, called Dunal, permits units to be first coated before being bored and machined.

During tests a production casting coated with the finish was put through a boring machine, then degreased and cleansed under high temperatures. A series of units were force fitted into the casting under extreme pressure and heat. Examination of the casting found

T-J spacemaker cylinder

Quality Engineered

to give quality results

with Extras . . .
at No Extra Cost!

You get more—much more—when you specify and use any of T-J's complete line of Spacemaker cylinders. The Spacemaker is engineered to give you better, more accurate, and longer service—offers, exclusively, many extras . . . that are STANDARD, AT NO EXTRA COST!

Designed to eliminate tie-rods, providing greater strength . . . saves space . . . reduces manhours and costs in all push-pull-lift operations. IMMEDIATE SHIPMENT in a wide range of styles and capacities, with 64,000 combinations. Write for Bulletin SM 155-3 with complete engineering details. The Tomkins-Johnson Co., Jackson, Mich.

METAL PISTON ROD SCRAPER . . . Standard at No Extra Cost!

NEW "SUPER" CUSHION FOR AIR . . . Standard at No Extra Cost!

CHROME PLATED CYLINDER BORES AND PISTON RODS . . . Standard at No Extra Cost!

ONE PIECE PISTON . . . Standard at No Extra Cost!

NEW "SELF-ALIGNING" MASTER CUSHION FOR HYDRAULIC USE . . . Standard at No Extra Cost!

NO TIE-RODS TO STRETCH . . . Standard at No Extra Cost!

STREAMLINED DESIGN . . . Oil Pressure to 750 P.S.I.—air to 200 P.S.I. Standard at No Extra Cost!

FORGED SOLID STEEL HEADS . . . Standard at No Extra Cost!

T-J TOMKINS-JOHNSON
RIVETORS, AIR AND HYDRAULIC CYLINDERS, CUTTERS, CLINCHERS

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no sign of cracking or marring and the coating was intact.

The casting also was subjected to alkali and acid baths, extreme cold and high temperatures. After the casting was dented and disfigured by hammers, the Dunal coating was left uncracked or marred.

The coating can be either dipped or sprayed and then baked for a permanent finish.

J. Landau & Co., Inc., Carlstadt, N. J. **T-12-16**

Form and Punch Shaper

Machining tapered punches or forms within a range of ± 3 deg is possible with this universal shaping machine, which can produce contours of all kinds. The machine also can produce surfaces and punches with curved necks to a guaranteed tolerance of ± 0.00025 in. in one setup. Incorporated into this K-15 shaper are speeds of 50, 75 and 110 strokes per minute; a working area up to 6 x 6¼ in.; stroke 0 to 6-in.

punch shaping, maximum length to beginning of radius 5¼ in.; a choice of electric direct-drive motors 220 or 440 volts 60 cycles, 3 phase; built-in lubrication, including instant stopping; and a base with enclosed tool cabinet.

The shaper, which turns out precise irregularly shaped stamping and electrode punches, employs a large dividing head with automatic circular feed, and a coordinate chuck that permits machining of radii, angles and tapers, automatically.

All controls and operational parts are incorporated into the machine and completely encased.

Jersey Mfg. Co., 455 Livingston St., Elizabeth, N. J. **T-12-17**

Milling Cutters

Microfinish milling cutters designed for milling aluminum and magnesium to tenths, hold a 30-microinch finish or better. This type milling cutter, known as Microcut, has highly finished cutting

edges and polished flutes. It is available in the inserted, wedge type and solid type cutters, including high-speed steel, cast alloys and carbide.

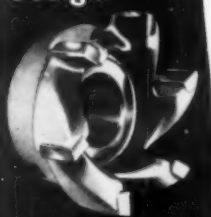
The O. K. Tool Co., Inc., Milford, N. H. **T-12-18**

Slide Head

This universal lathe slide head provides accurate boring, recessing, grooving, and backfacing. Designed for easy precision use, the head allows quick hairline adjustment of cutting tools by

SANDVIK
Coromant
Carbide-Tipped
SHELL END MILLS

Have Exclusive Triple-Economy Design



Coromant S 26
For Face Milling and Square Shoulder Milling.
Available in 3 sizes.

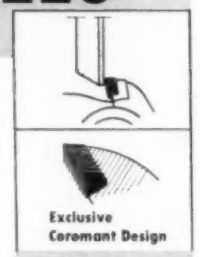
Coromant S 27
For Heavy Duty Face Milling.
Available in 3 sizes.

SS 182

❶ FASTER, EASIER, REGRINDING
Coromant teeth are seated at higher angle than is required by the radial rake. You simply grind a suitable primary land along the cutting edge rather than taking off the entire top surface of the blank as required by conventional type. Coromant saves time and grinding wheels.

❷ LONGER TOOL LIFE
Streamlined Coromant body minimizes the amount of carbide removed in regrinding. You retain far greater tip thickness for the life of the cutter than is possible with conventional designs.

❸ EASIER, MORE ECONOMICAL CHANGE OF RADIAL RAKE
Coromant cutters have extra "angle capacity" . . . require less carbide removal.



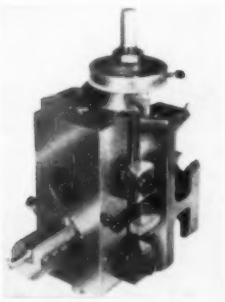
For complete data on all sizes of these Coromant mills ask for this free folder.

SANDVIK STEEL, INC.
1702 Nevins Road, Fair Lawn, N. J.
SW 7-6200 • In N.Y.C. AL 5-2200
CHICAGO
230 N. Michigan Ave., FR 2-5638
CLEVELAND
8650 Brookpark Rd., ON 1-3205
DETROIT
14131 Puritan Ave., BR 3-8474
LOS ANGELES
3338 South Malt Ave., RA 3-9116
In Canada
SANDVIK CANADIAN LTD., Montreal, Toronto, Vancouver

FOR FURTHER INFORMATION, USE READER SERVICE CARD, INDICATE A-12-120

the screw and dial principle. Dovetail and taper gib construction of this head assures rigidity.

The slide head requires minimum set-up time and it is useful for medium runs of either rough or finish work. It is manufactured to fit No. 3 Warner &

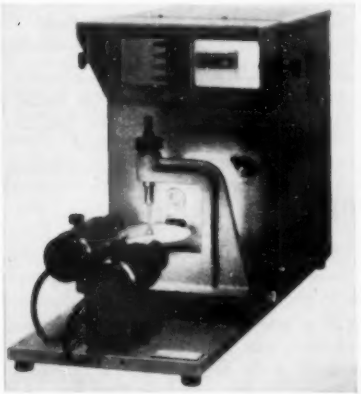


Swasey, No. 3 Jones & Lamson, and No. 3 Gisholt turret lathes. Adaptors are available for all others, including ram or saddle type turret lathes.

G/K Products, Rosemead, Calif. **T-12-19**

Dual Image Comparator

On this dual image production comparator, two simultaneous images through separate optical systems are presented for the operator. Effects of adjustments in one plane are immediately apparent in the second plane. Fast, accurate checking is possible



without resetting the part and repeating adjustments.

The unit shown is used in checking runout of worm and disk assemblies for watt-hour meters. Magnifications, in this instance, are alike for both images. Screen size is purposely reduced to include only the salient features in question. Screen and fixture adjustments are provided so that setting to a master or changes in specifications may be accommodated. The optical systems are designed for the specific job and preset by the manufacturer. Compact in design, the unit occupies about 1½ sq ft of bench space.

Optical systems may be of different magnifications, of differing focal lengths. The optics may be parallel projection paths, as shown, or intersecting paths. Screens to accommodate various magnifications and part sizes range from 3 x 3 in. square to 20-in. diameter, with separate screens for each view or both images appearing on a single screen. Triple systems for checking three coordinates or features at one time, also are possible.

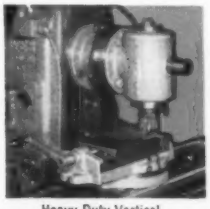
Stocker & Yale, Inc., Marblehead, Mass. **T-12-20**

Pneumatic Feed Attachments

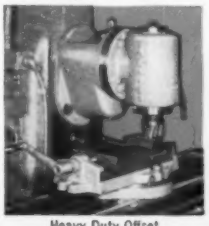
Line of heavy duty drill press air feed attachments provides automatic or semiautomatic precision control of spindle feed and retraction on standard single and multiple spindle drilling machines.

This compact conversion package can be installed easily on any make of heavy duty drill press, using pinion adapters to fit the machine. It will handle applications requiring up to 2,000 lb total drill point pressure, and will duplicate any hand pressure.

Power is from twin double-acting pneumatic cylinders in tandem; an ef-



Heavy Duty Vertical Milling Attachment



Heavy Duty Offset Vertical Milling Attachment

Universal Milling Attachment

Toolmakers Overarm

Heavy duty attachments increase versatility of dependable, low-cost

GREAVES MILLS

"THE MOST MILL FOR THE LEAST MONEY"

A full line of attachments and accessories offer outstanding flexibility for all types of milling operations . . . with GREAVES MILLS. Make your own comparison of 22 specifications of Greaves and 7 other leading milling machines.

Send coupon for FREE Comparison Chart and detailed descriptive literature on easy-to-use attachments.

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Send Comparison Chart. I will make my own comparison of GREAVES MILLS with other makes.
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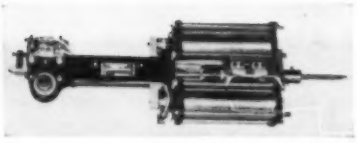
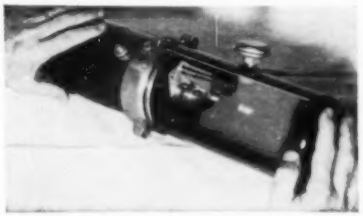


fective hydraulic checking mechanism provides precision tool control. The cylinders, designed for operation at air pressures to 100 psi supply thrust for the downward feed of the spindle, and automatically retract it to the starting position after reaching a preset depth limit. A Micro-Valve maintains uniform control of air pressure under heavy duty machining operations to assure accurate tool feeding.

Renco-Aire, Div. of Cleveland Industries, Inc., 64 Old Orchard, Skokie, Ill. **T-12-21**

Power Packages

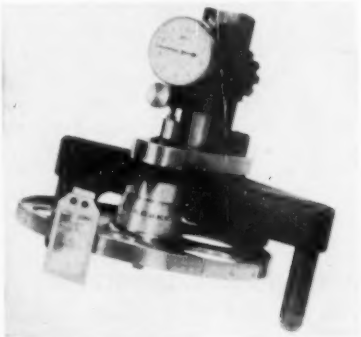
Line of self-contained power packages for producing hydraulic power from an electric source incorporates an electric motor, hydraulic gear pump with integral relief valve, check valve and reservoir in one assembly. Pressure loaded bearings automatically compensate for wear to assure high volumetric efficiency and long life. Fewer moving parts minimize maintenance requirements. Capacity of the gear pump ranges from 0.36 to 0.80 gpm. The line has integral relief and check valves and provides control of the load in lifting, lowering and holding positions, even in cases of motor stall.



Wooster Div., Borg-Warner Corp., Wooster, Ohio. **T-12-22**

Gage Checker

This testing device checks accuracy of dial indicators. Barrel of the instrument is accurate to 0.000030 in. Graduations on its 8-in. diameter ring are accurate to 2 sec of an arc of the circumference. The portable testing unit is capable of checking indicators with ranges up to 1 in., direct to 0.0001 in.



Its cast-iron base, with three point suspension, is tilted to proper angle for easy reading.

B. C. Ames Co., Waltham, Mass. **T-12-23**

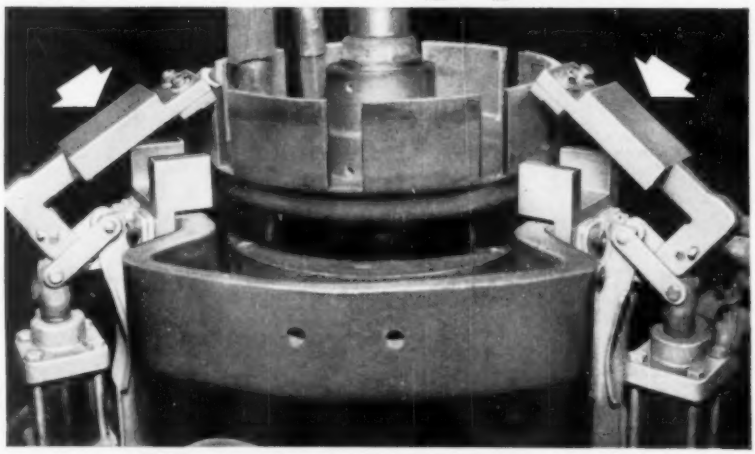
USE READER SERVICE CARD ON PAGE 135 TO REQUEST ADDITIONAL TOOLS OF TODAY INFORMATION

Injection Molding Machine

Model 703 6-oz injection molding machine permits economical production of large or small pieces. All thermoplastic materials can be molded. Plasticizing capacity is 80 lb/hr; rate of injection is 465 in. ^{3}/min., and injection pressure is 19,600 psi.

Design combines vertical clamping with horizontal combing. Degated parts are ejected horizontally and can be deposited on a conveyor to minimize scratching or other damage to surfaces. Barriers can be incorporated into the horizontal comb to sort different pieces of a family mold into separate bins, as well as sprues and runners. Pieces can be kept oriented with respect to each other exactly as they were molded; this permits automatic packaging at the ma-

BIG--for big jobs



NEVER SEND A BOY—here's the Knu-Vise clamp AO-200.

LAPEER CLAMPS FOR ARC WELDING

In the plant of a midwestern automotive parts manufacturer, air operated Knu-Vise clamps are an important part of a work holding fixture for arc welding. Shown is the operation where center hubs are welded into the high clutch splitter housing for automatic truck transmissions.

No job for a panty-waist, the husky Lapeer clamps have to grab securely—hold rigidly—let go instantly. They are part of a family of more than 150 models of clamps and pliers designed to do a tremendous number of holding jobs. Some are air-operated, others hand operated. All of them do workhorse jobs in industry holding big parts, small parts, unwieldy parts. Write today for more information.

Manufacturers of over 150 models of manually and air-operated clamps and pliers

KNU-VISE PRODUCTS — LAPEER MANUFACTURING CO.

3053 DAVISON ROAD
LAPEER, MICHIGAN

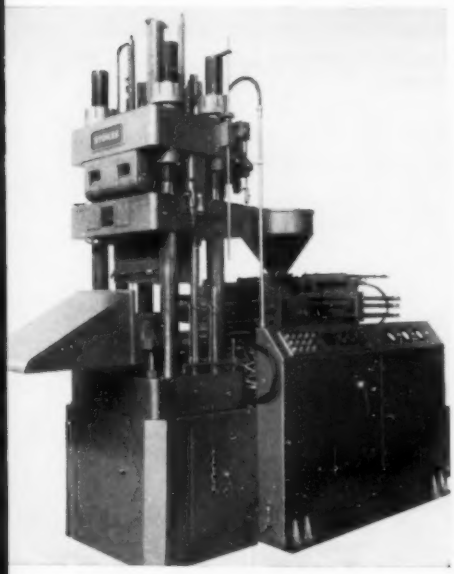
WESTERN DIV.: PECK and LEWIS CORPORATION
4436 Long Beach Ave., Los Angeles 58, Calif., ADams 3-7146
CANADIAN DIV.: HIGGINSON EQUIP. SALES LTD.
113 Pettit Road, Burlington, Ontario

FOR FURTHER INFORMATION, USE READER SERVICE CARD; INDICATE A-12-122

chine and may facilitate automatic assembly operations later on.

Vertical configuration of the Model 703 simplifies mold setup and facilitates handling of inserts in semiautomatic molding operations. It eliminates overhanging loads on press platens, conserves floor space, and provides an efficient mold working height.

Positive shutoff at the injection nozzle permits the molding of nylon without "drooling" and without changing the nozzle. This nozzle shutoff feature also



permits prepacking the injection cylinder at high pressure, simultaneously with the cooling cycle, and gives fast filling and compression and good plasticizing.

The injection plunger can be retracted instantaneously, even before the gates are fully set up. Cycle time is 8 seconds from mold opening to the beginning of fill.

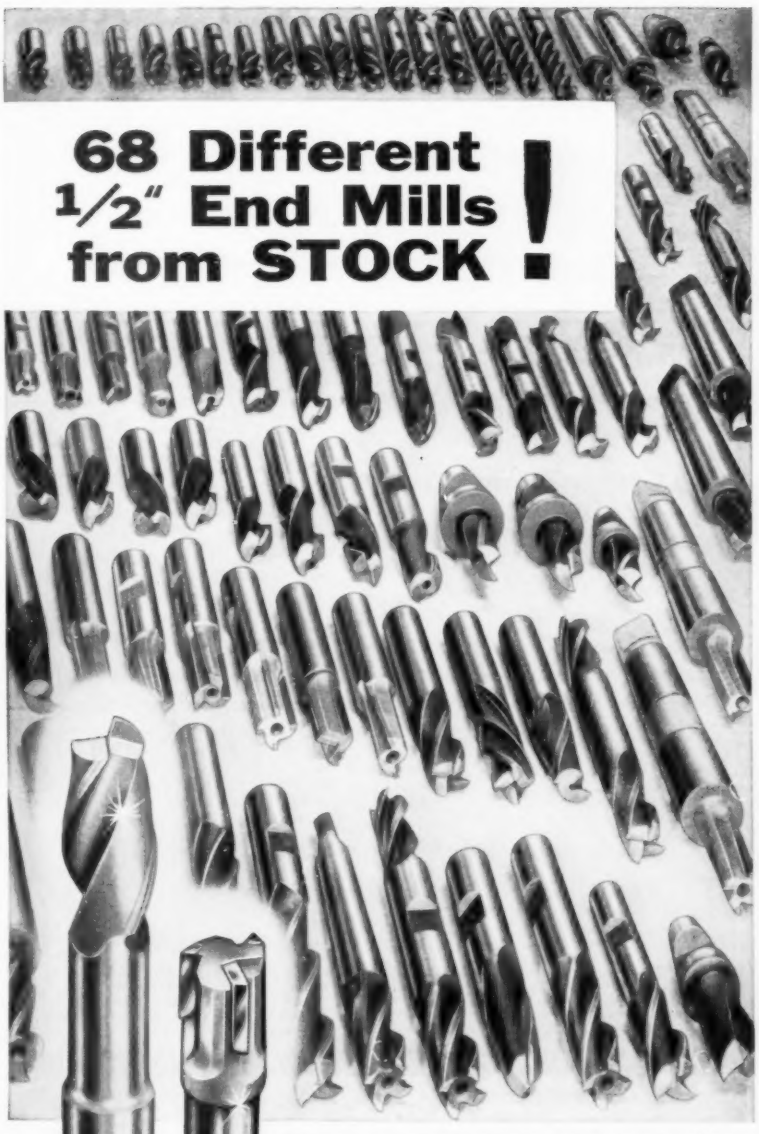
F. J. Stokes Corp., 5500 Tabor Rd., Philadelphia 20, Pa. **T-12-24**

Collet Closer

Nonrotating air powered collet closer for the R-0 universal form relieving fixture facilitates interchanging of tools and adapts the equipment to high-speed production sharpening.

The closer operates on shop air at 60 psi and is actuated by a double acting foot operated valve: the collet is locked closed when the bottom pedal is depressed and stays closed until top pedal is depressed.

The chuck and draw bar assembly are mounted in the standard motor driven fixture without alteration. The draw bar rotates in the closer on a pre-



Most tool manufacturers would list many of these tools as "specials". At Brown & Sharpe they're all "standards"—off-the-shelf.
See your distributor. Never before such tooling service! Saves worry, waiting and costly "special tooling" over and over again.
Moral: Whether it's High Speed Steel, Carbide Tipped or Solid Carbide . . . for production *profit improvement,* specify B&S—NELCO.

SEND FOR CATALOG—To: Cutting Tool Division, Brown & Sharpe Mfg. Co., Providence 1, Rhode Island.

FOR THAT EXTRA EDGE IN PRODUCTION

Brown & Sharpe

CUTTING TOOL DIVISION

HIGH SPEED STEEL CUTTERS

NELCO CARBIDE TOOLS

PROGRESS IN PRECISION FOR 125 YEARS

FOR FURTHER NFORMATION, USE READER SERVICE CARD, INDICATE A-12-123

The Taft-Peirce CompAIRator... all-in-one package for gaging, size sensing and measuring

This is the Taft-Peirce Model E CompAIRator with hose-mounted standard Air Plug Gage. The Model E features fast, visual readout, extreme accuracy and great versatility. Air Plug Gages are used for through-hole, blind hole and counter-bored hole inspections. Very small holes and bores with limited depth can also be handled.

CompAIRators are simple, portable units for bench or machine inspection, for adaptation to in-process gaging; and for use with a variety of fixtures for shop-wide use.

Air Ring Gages measure external diameters from .125" up. Three nozzle design available for checking centerless ground diameters.

Air Snap Gages used with the Model E CompAIRator provide greater economy and more gaging flexibility for checking production or job lots.

The new Air Capsule provides direct contact gaging adaptable to a wide variety of applications. Replaces standard AGD dial indicators.

The new Model E CompAIRator is a compact, low-cost basic air gage for use with a wide variety of gaging accessories. It features the exclusive Taft-Peirce Velocity circuit which produces fast, accurate readings, and can be quickly changed to any one of four magnifications for extra versatility. The smallest diameters — ID's to .055" — can be checked, as well as tolerances from .0001" to .125".

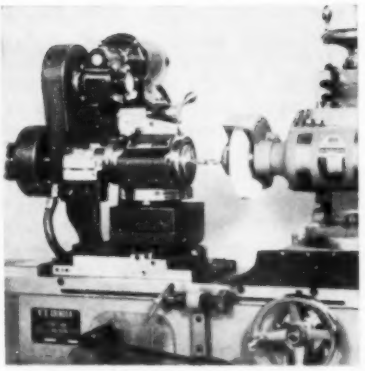
In addition to the standard features shown above, special fixtures can be designed for practically any application. Maximum economy can frequently be obtained by using two-and-three-dial CompAIRators to measure combinations of dimensions at the same time, thus saving time and increasing accuracy.

Try Taft-Peirce CompAIRator Gaging in your Plant. Your nearest Taft-Peirce representative is ready to show you the Model E CompAIRator plus examples of a wide variety of gaging systems which can save you time and money. Call or write today.

TAKE IT TO TAFT-PEIRCE

TAFT-PEIRCE MANUFACTURING COMPANY
WOONSOCKET, RHODE ISLAND

FOR FURTHER INFORMATION, USE READER SERVICE CARD; INDICATE A-12-124



Chuck at left is mounted on motorized fixture.

cision needle bearing and thrust is taken on two shielded ball thrust bearings.

Royal Oak Tool & Machine Co., 29800 Stephenson Hwy., Royal Oak, Mich. **T-12-25**

Abrasive Belt Grinder

Designed for grinding inside surfaces where clearance is a major factor as well as to handle small jobs, Model TS-90 abrasive belt grinder uses a 90-in. belt in widths of 1 or 2 in. It is

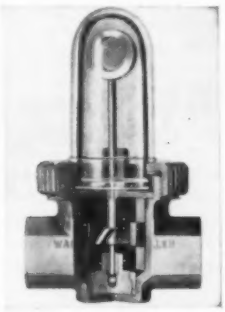
suitable for removing flash or parting lines on nonferrous castings, molded rubber and plastic parts; for sharpening special shape dies and for sanding of wood scroll work. A rubber covered contact wheel and adjustable tilting table are available accessories.

Grinding & Polishing Machinery Corp., 2530 Winthrop Ave., Indianapolis 5, Ind. **T-12-26**

Flow Indicator

This safety signal shows at a glance whether flow is taking place. It incorporates a chromium plated ring that spins under a glass dome during flow and prevents chance of misreading. Applications are to water cooling systems, lubricating systems and the like.

The variable flow indicators can be easily reset in the field for high or low



range. They are available with die-cast brass body in ½, ¾ and 1 in. pipe sizes for flows from 0.72 to 24 gpm. Other models are available for flows from 0.075 to 120 gpm in pipe sizes up to 3 in.

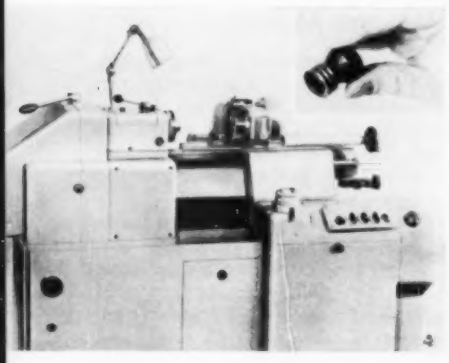
McIntosh Equipment Corp., Walker Crosweller Div., 15 Park Row, New York 38, N. Y. **T-12-27**

USE READER SERVICE CARD ON PAGE 135 TO REQUEST ADDITIONAL TOOLS OF TODAY INFORMATION

Thread Cutting Machine

The Jaggi MF-57 semiautomatic thread generating machine, which cuts accurate external and internal threads, can be economically used for lots of less than 10 pieces. It can be operated easily by unskilled labor.

The machine utilizes the "thread whirling" principle in which tungsten-carbide tools whirl around the work component, cutting threads that are accurate in pitch diameter and very smooth in finish. The threads can be



Atrax PROGRESS REPORT

SOLID CARBIDE TOOLS

CASE HISTORY #19

MAJOR AUTOMOBILE MANUFACTURER

Atrax BORING TOOL Series 2010

OPERATION Boring 20 holes around 4½" O.D. x 3" I.D. Stator Blade Rings

MATERIAL Cast Iron

SPEED-FEED 8,000 r.p.m. at 10" per min. stock removal .014"

PRODUCTION 10,000 holes per grind. Use of this Atrax tool reduced number of special machines needed to maintain production from 18 to 6.

CASE HISTORY #30

MID-WEST PUMP MANUFACTURER

Atrax SOLID CARBIDE BUR Shape A-184

OPERATION Plunge cut to ¼" depth using milling machine

MATERIAL Beryllium Copper

SPEED-FEED Slow speed-hand fed

PRODUCTION Extremely fine surface finish resulted with virtually no wear on Atrax Solid Carbide Bur.

CASE HISTORY #31

EASTERN AIRCRAFT MANUFACTURER

Atrax END MILL Series 1505 (Slow Spiral)

OPERATION Reworking and salvaging hardened dies and fixtures for retooling program

MATERIAL Hardened steel Rockwell C-58 and case hardened materials

SPEED 1200 r.p.m. with hand feed

PRODUCTION Atrax Solid Carbide Slow Spiral End Mills used on this rework and salvaging application proved extremely successful in time and material savings.

Atrax

SEND TODAY for 96 page "STANDARD REFERENCE" on Carbide Tooling!

THE ATRAX COMPANY

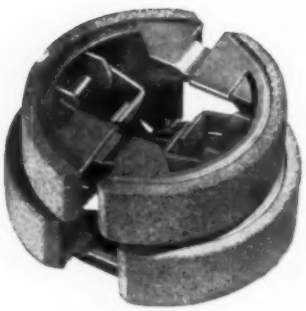
Newington 11, Connecticut

FOR FURTHER INFORMATION, USE READER SERVICE CARD; INDICATE A-12-125

Twice the Power!
Twice the Life!

NEW
Jarvis

"TORQOMATIC" TAPPING HEADS



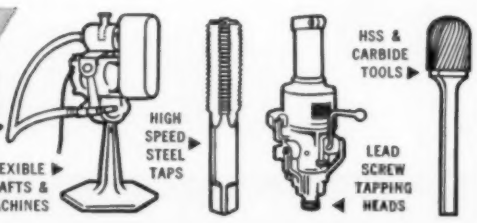
Here is the new Jarvis "Torqomatic" tapping attachment—completely redesigned inside and out! The rugged magnesium body now houses a unique clutch with "straight-line" action . . . response to fingertip pressure on the drill press handle is instantaneous.

Jarvis Torqomatics are tortionally-driven and may be run at optimum speed for the material being tapped. Because it operates with the least amount of pressure on the tap itself, a Torqomatic keeps tap wear and breakage at a minimum . . . produces accurate threads hour after hour.

Slightest pressure of the tap against the work causes the clutch to be fully engaged. Straight-line action of this new clutch provides a 100% driving surface, eliminates any slippage. This basic design feature results in twice the power of the former model, with clutch life more than doubled.

Torqomatic tapping heads are available in 9 standard models, with chuck capacities of 3/16", 3/8", or 5/8". They can be furnished to fit any drill press or tapping machine. For a real demonstration of tapping speed, accuracy and trouble-free performance, get in touch with your Jarvis representative!

Jarvis



JARVIS CORPORATION • MIDDLETOWN, CONNECTICUT
FOR FURTHER INFORMATION, USE READER SERVICE CARD; INDICATE A-12-126

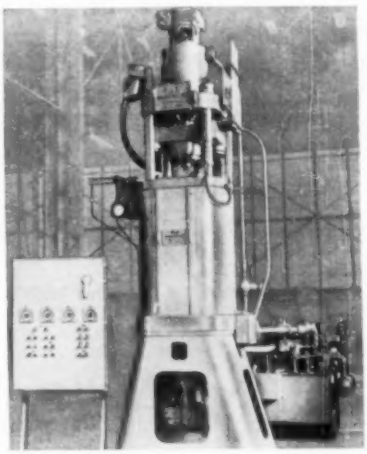
started at any given place on the work component and require no previous recessing. Single pitch as well as multi-pitch threads can be produced. Speeds of both the tool spindle and the work carrying spindle are readily adjustable to job requirements.

Maximum diameter of the external threads produced on the machine is $2\frac{3}{8}$ in. or, with special toolholder, $3\frac{3}{8}$ in. Maximum diameter of the internal threads is $3\frac{3}{8}$ in., the minimum internal thread diameter is $\frac{3}{8}$ in.

Carl Hirschmann Co., Inc., 30 Park Ave., Manhasset, N. Y. **T-12-28**

Powder Compacting Press

Two entirely different materials can be compressed in the same operation by this automatic hydraulic powder compacting press. Two independent shuttle type feed shoes and hoppers make possible compacting at production speeds up to 15 per minute.



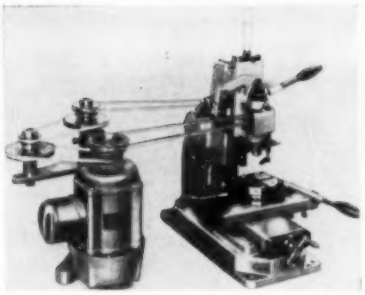
Models of this type are built in 50, 100, 200, 300 and 500-ton sizes and will compact both layers of material into one unit in one operation, accurate as to weight and dimensional tolerances.

Kux Machine Co., 6725 N. Ridge, Chicago 16, Ill. **T-12-29**

Vertical Miller

Bench type vertical milling machine with automatic feed is suitable for rapid production of small parts for mechanical instruments where accuracy is vital. The motor is mounted separately to allow fine finishes and chatterless operation even at high speeds.

The machine, made by Erhard Jauch, Western Germany, is adapted to perform any kind of milling and recessing work. Both milling cutters and twist drills can be mounted. Micrometer adjustment in connection with a rigid stop



assures working accuracy of 0.0002 in.

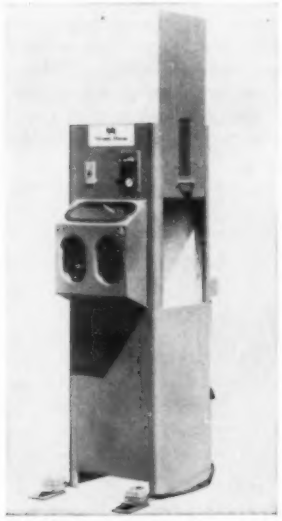
Vertical cam controlled feeding movement provides rapid approach, slower feed, stop, quick return of the spindle to the initial position. The feeding stroke is adapted to suit requirements.

Special bronze bearings or roller bearings can be furnished for speeds up to 12,000 rpm.

Distributed by A & H von Tsurikov, 755 Lake Ave., Rochester, N. Y. **T-12-30**

Liquid Blasting Machine

Designed for high production and precision cleaning, finishing, peening, burnishing, and deburring of metal parts, Model 15 liquid-blasting machine can maintain microfinishes ranging

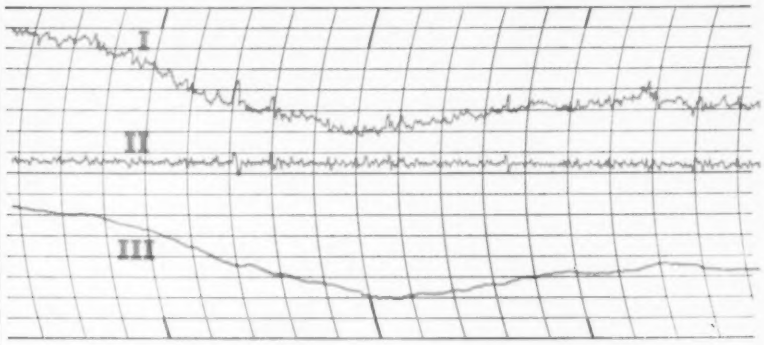


from 16 to 250 by adjusting air pressures and the size and type of abrasive medias used. The machine can be adapted to existing air supplies. Air required to operate the new unit ranges from 20 to 65 cfm at 90 psi.

Internal working area of the unit is 20 x 20 in.; a counterbalanced, side-entry door enables the processing of larger parts. For high-production finishing of small parts, the machine can be equipped with a tumbling barrel for automatic finishing.

PROFICORDER®

MAKES MOUNTAINS FROM MILLIONTHS

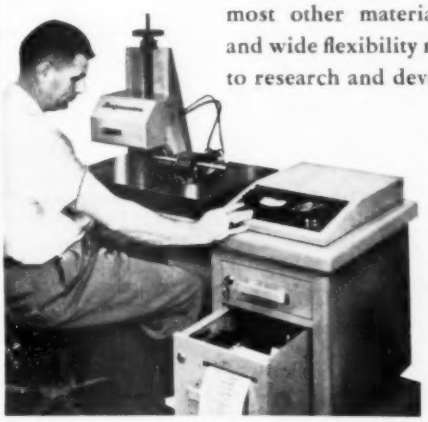


Three Proficorder records of same portion of a surface, reproduced ½ size, showing (I) total profile, (II) roughness profile, and (III) waviness profile. Note range of detail.

THE PROFICORDER draws a magnified profile of machined and finished surfaces, showing the *height, width* and *relative position* of the surface irregularities. It clearly shows any desired detail from over-all contour to fine roughness. Accordingly —

These charts permit detailed study and comparison of waviness . . . roughness . . . porosity . . . flaws . . . wear . . . and the effects of finishing processes.

The Proficorder will show (I) the total profile, (II) roughness alone, or (III) waviness, steps and other widely-spaced irregularities with roughness omitted. It is used on metals, paper, plastics, ceramics, and most other materials. Ease of operation and wide flexibility make it especially suited to research and development work.



FREE
BULLETIN LT24

gives details. Write for it! And let us furnish you with profile charts of surfaces in which you are interested.

Proficorder is a registered trade-mark.

Made by the Profilometer® people —

MICROMETRICAL MANUFACTURING CO.

349 S. MAIN ST. ANN ARBOR, MICHIGAN

FOR FURTHER NFORMATION, USE READER SERVICE CARD; INDICATE A-12-127

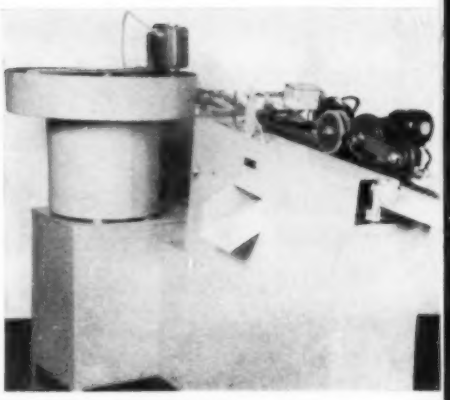
Full agitation of abrasives and a constant and positive feed to the blasting gun is provided by a centrifugal-design pump capable of producing an output of 35 gpm. Vapors and fog are removed through a wire-mesh filter which traps over 98 percent of all paricles from the air strainer.

Two electrical foot switches leave the operator's hands free. One switch controls the air pressure which can be regulated from zero to 160 psi; the other controls a window-washing mechanism.

Hydro-Hone Corp., 7516 Pacific Blvd., Huntington Park, Calif. **T-12-31**

Cylinder Feeder

Used to feed cylindrical parts to a centerless grinding machine, this cylindrical feeder will handle a variety of sizes and shapes regardless of the ratio of length to diameter, and orient the parts so that they are fed as a continuous tube to the centerless grinder. Square races are oriented without difficulty. The machine can be changed over from one size to another in a few minutes; no change-over parts are required. The final discharge chute is self-adjusting with the feed mechanism.



The feeder will handle cylindrical parts from $\frac{3}{8}$ to 3 in. in diameter. A linear rate of feed in excess of 100 ipm is maintained. There is constant back pressure of the parts into the centerless grinder, and an electronic control prevents overfeed.

U. S. Engineering Co., 40-24 22nd St., Long Island City, N. Y. **T-12-32**

Bench Welder

Model R-600 hand-operated spot welder can be installed or moved easily and operates from an ordinary house lighting circuit. The press type precision bench welder applies pressure in a straight line, preventing skidding of aligned parts. Cam-lever action produces required high pressure with minimum effort. It makes good spot welds on mild or stainless steel through 26

ga, and cross-wire welds through two pieces of 3/12-in. clean steel wire. It also welds other metals and alloys.

A heavy-duty pass-through contactor turns welding current on and off automatically. An optional automatic electronic timer is available. Three-point heat control provides flexibility. Standard No. 1 MT welding points (not water-cooled) are replaceable.

Peer, Inc., 1200-1248 Milton St., Benton Harbor, Mich. **T-12-33**

REDUCE
Precision Hole Grinding Costs
USING AN
Onsrud®
D1-S
HOLE GRINDER
MOUNTED ON YOUR

OR MOUNT ON JIG BORER TO CONVERT MACHINE TO PRECISION JIG GRINDER

Grind precision holes at amazingly low costs with the D1-S . . . using your present machine tools. A completely RIGID unit guaranteed not to deflect in its vertical alignment. Grease-shielded, long life bearings. Capacity up to 2¾" diameter with ¾" wheel . . . and up to 4" diameter with adapter. Proper high speed and power for dependable, fast operation with toughest steels.

ONSRUD MACHINE WORKS, INC.
PORTABLE TOOL DIVISION
7726 Lehigh Avenue Niles 48, Illinois
(Suburb of Chicago)

WRITE FOR FREE D1-S HOLE GRINDER BULLETIN 1126
FOR FURTHER INFORMATION, USE READER SERVICE CARD; INDICATE A-12-128

Countersink

Adjustable micrometer-stop countersink can be used for volume production work wherever chucking is available.

The steel alloy shaft operates within an extra large self-lubricating bearing. Rapid adjustment for depth of cut is made by retracting the thimble and rotating to any desired position. When released, precise serrations provide positive locking. Final cut is accurate with ±0.001 in. limits. In use, a preloaded movement of the shaft assures accurate

alignment of the shield with the work. Shields are available in several types and sizes.

Cutting faces and pilots are ground simultaneously to assure absolute parallelism with a resultant higher accuracy. The tools are available in sizes from 3/8 to 1 1/2 in., in five standard angles.

For dual use the countersink may be used with hollow end mills developed primarily to remove collars from hi-shear rivets without damage to pins.

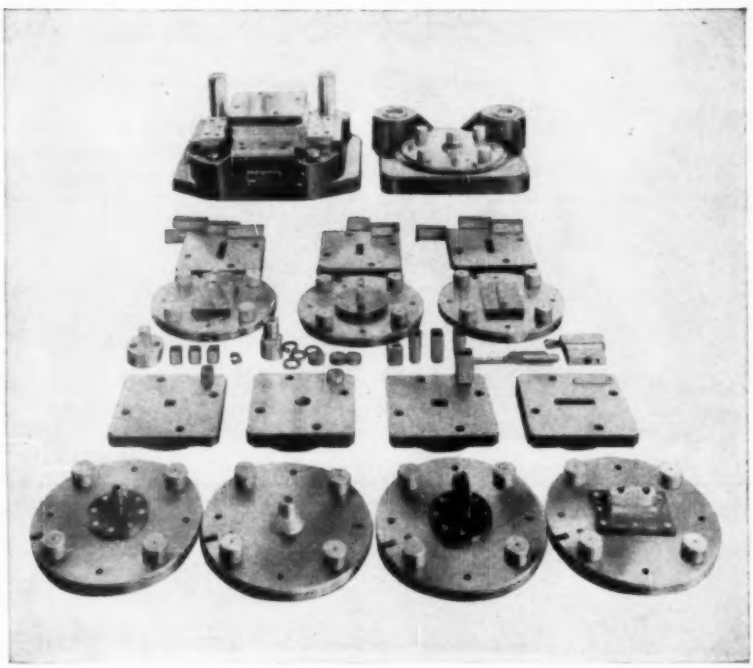
Schrillo Aero Tool Engineering Co., 8715 Melrose Ave., Los Angeles 46, Calif. **T-12-34**

Vertical Grinding Machine

The 1200 Series vertical precision grinding machines, incorporating fixed rail design, are available in two sizes and two models. The 1224 size has a 24 in. diameter table with 36 in. maximum swing capacity. The 1236/42 (illustrated) size has a 36 or 42 in. diameter table with 48 in. maximum swing capacity. The compound has a swivel of 45 deg either side of center, while the grinding spindle has a swivel of 90 deg either side of slide center.

Each size is available with either a belt driven grinding spindle or a direct connected grinding spindle. The belt driven model is especially suitable for bore grinding operations. The direct connected model is suitable for multiple grinding operations on ID, OD, and associated surfaces where the versatile feed directions of the spindle-slide spindles are available.

The machines are arranged to permit feed, traverse, and reciprocation in both horizontal and vertical directions. These



ALL THIS FROM ONE BASIC DIE

One basic die with 8 different sets of cutting members was used to trim the 8 parts shown. Some are round, some are square, some are rectangular and the one in the die is irregular. Depths vary from ¼" to 3". **Only one basic die is used.**

A Brehm "Shimmy" Die with angular cams can be designed for almost anything you need trimmed — fountain pen ferrules, artillery cases, watch cases, burial vaults, automotive, kitchen, radio and television accessories and parts. *Send part prints for quotation on Brehm "Shimmy" and related dies, such as blank, form pierce.*

THE SHIMMY DIE — VULCAN TOOL COMPANY — REGISTERED U.S. PATENT OFF.

Brehm® trimming dies

ENGINEERING • PROCESSING • BUILDING • TOOLS
DIES • SPECIAL MACHINES • VULCANAIRE JIG
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VULCAN tools

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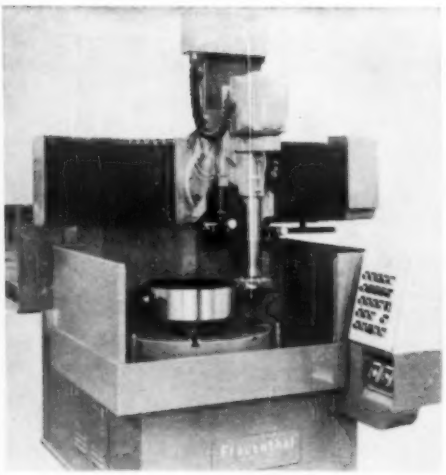


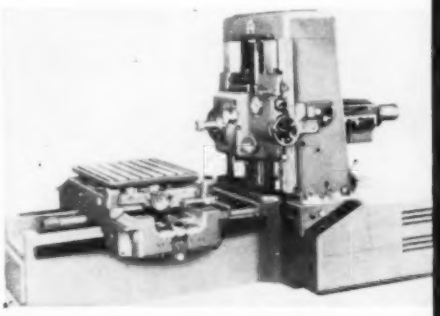
cycles can be obtained: Feed horizontally, reciprocate vertically; feed vertically, reciprocate horizontally; feed horizontally only; feed vertically only. All operating controls are mounted in a pushbutton control panel.

The heavy-duty work spindle is accurate to 0.0001 in. at the spindle nose. Accurate control of work spindle speeds is obtained by an electronically controlled motor drive. Infinitely adjustable spindle speeds of 2 to 235 rpm on the 1224 size, and 2 to 200 rpm on the 1236/42 size are obtained by means of potentiometer control. In addition, the drive has dynamic braking and is reversible.

Frauenthal Div., The Kaydon Engineering Corp., Muskegon, Mich. **T-12-35**

Jig Borer

A horizontal optical jig borer, designated Dixi 75, affords unusually large capacity for jig boring with optical interrelationship between bores at all angles. The 3-in. spindle and 8 hp drive provides jig boring accuracy with heavy cutting capacity. Projected optical settings provide direct readings of 0.00005



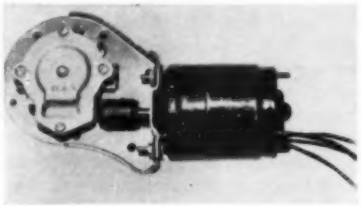
in. for linear motions and 1 sec of arc for the built-in rotary table. Semiautomatic positioning will also be available.

The machine has large table and travels, separate reservoir and recirculating lubrication for the headstock, electrically interlocked hydraulic motion, fast spindle speeds, simplified functional controls and optional rear support.

M.B.I. Export & Import Ltd., Div. of Machinery Builders, Inc., 475 Grand Concourse, Bronx 51, N. Y. **T-12-36**

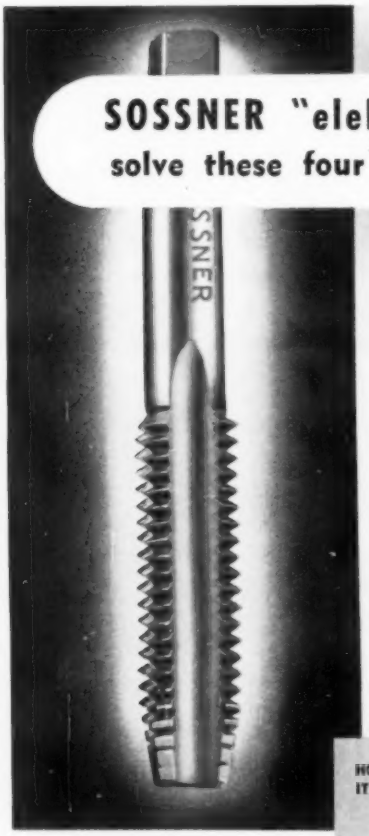
Gear Reducer

Motor revolutions are reduced and torque increased by this worm gear power transmitter for use in rack and pinion, gear and pinion, or friction drive operations. Designed for operation by fractional horsepower motors



up to 1/9 hp at 2000 rpm, 1/6 hp at 3000 rpm, or 1/5 hp at 4000 rpm, the gear reduction unit may be used for any operation in which electrical power must be converted to rotary or straight-line mechanical actuation.

Units are available with two transmission ratios—52:1 and 27.5:1 with either a six or eight-tooth pinion. Friction drive pinions are special. Input shaft dimensions are $\frac{1}{4}$ in. in diam



SOSSNER "elektraLUBE" TAPS*
solve these four tapping problems!

• PICK UP
• LOADING
• WELDING
• GALLING

What is "elektraLUBE"?

"elektraLUBE" is an exclusive SOSSNER development. Briefly, "elektraLUBE" is a highly ductile lubricating deposit firmly bonded to the surface of the tap and anchored into the ground pores. Under working pressures, this deposit is further compressed into the pores and burnished to a bright, slippery consistency. "elektraLUBE" takes over as a super lubricant where conventional lubricants stop functioning.

*"elektraLUBE" Taps are manufactured only by SOSSNER.

HOW DOES IT WORK?

High pressures at A & B (see sketch) force out any conventional lubricant. "elektraLUBE" is an integral part of the tap and remains to provide permanent lubrication between tap and work piece.

SOSSNER TAP & TOOL CORPORATION
29 BROADWAY, LYNBROOK, L. I., N. Y.

Inquiries from representatives and distributors are invited.

Factory Warehouses In New York and Los Angeles
Dealer Stocks In Other Cities

FOR FURTHER INFORMATION, USE READER SERVICE CARD; INDICATE A-12-130

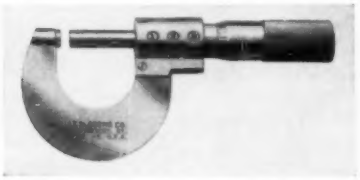
and 3/16 in. across the flats. The transmitter measures 3 x 3½ x 1½ in. Output is at right angles to the motor shaft input. Standard mounting plates for in-line mounting of the transmitter and motor are available as are couplings and motors of various sizes and capacities.

Although designed to operate with both reversible and one-way motors, the unit will lock against reversing torques on the output shaft. No additional nonreversible mechanism is required.

Huppower Div., Hupp Corp., 7450 Melville Ave., Detroit 17, Mich. **T-12-37**

Micrometer

Direct reading micrometer, called the Speedmike, is read from a counter type dial; there is no need to calculate read-



ings, thus providing definite accuracy.

Workers using the micrometer can take readings quickly and accurately.

J. T. Slocomb Co., South Glastonbury, Conn. **T-12-38**

USE READER SERVICE CARD ON PAGE 135 TO REQUEST ADDITIONAL TOOLS OF TODAY INFORMATION

Parts Feeder

The Auto-Positioner consists essentially of an automatic parts positioning head and a parts feeder which guides the part into place. Mounted on a dual column for compactness, rigidity and convenient adjustment, both units are actuated by compressed air. The feeder requires no auxiliary motor or vibrator. No curved tracks are used and it is not necessary to depend on gravity for placing the part in the chuck.

Designed to handle piece parts ranging from 1/16 to 2 in. size, the positioner automatically transfers parts from feeder to fixture at speeds up to 6000 per hour. It is easily adapted to various machines, fixtures and tables for parts handling and assembly.

The simple feeder for the positioner head has a straight track and a positive-acting escapement, which permits low-angle track mounting. Mounting between the members of the dual column permits easy adjustment and permits close nesting of the units when installed at multiple stations. A double-acting air cylinder actuates both the feeder

drum and the shuttle type escapement.

A built-in sensing mechanism in the positioner head causes the machine to stop if a part is missing or malformed. The machine stops with the ram in the forward position; this facilitates locating the source of trouble.

The Auto-Positioner can be furnished as a single station with floor mount and a foot treadle for initiating the cycle, or as a fully automatic station with electrical connections to automatically initiate the cycle. Accurate locating adjustments are provided. Units can be furnished fully tooled for the job, or arranged for other types of feeders and for placement tooling to be supplied by the user.

Dixon Automatic Tool, Inc., 2300 - 23rd Ave., Rockford, Ill. **T-12-39**

Consult these **CIRCLE R** *Specialists*

BURBANK — Production Machinery Sales Inc
CHICAGO — Donald Robertson & Co.
CLEVELAND — Production Tool Co.
DAYTON — J. R. Kuntz Company
DETROIT — A. D. Spruce
HACKENSACK — The Eaton Company
INDIANAPOLIS — Walter F. Greene & Associates
MILWAUKEE — Ford Tool Co.
NEW YORK CITY — J. B. Cremonin (Export)
PHILADELPHIA — General Tool Sales Co.
PHOENIX — DiEugenio Tool Center
PITTSBURGH — Ralph Esposito & Co.
PROVIDENCE — Fred J. McMillen
ROCHESTER — James O. Horne
ST. LOUIS — B. C. MacDonald & Co.
WESTBURY, L. I. — The Eaton Company
MONTREAL — Humphrey B. Walton

658-7

Curled chip disposal action of these Circle R Deep-Cut slitting and cut off saws enables heavier feeding, while efficient tooth design assures longer life. Your material is square cut, with milled finish and no burr. Circle R precision underwrites your precision. We can hold our products within very close tolerances, where required. Visit us for Factory Consultation Service — or call in our representative.

SEND FOR CATALOG O

METAL SLITTING SAWS • COPPER SLITTING SAWS • SCREW SLOTTING SAWS • COMMUTATOR SLOTTING SAWS • JEWELERS SLOTTING SAWS • CUT OFF SAWS • CIRCULAR KNIVES & ROTARY SHEAR BLADES • CIRCOLOY STEEL SAWS • SOLID & TIPPED TUNGSTEN CARBIDE SAWS • COMBINED DRILLS & COUNTERSINKS • CENTER REAMERS

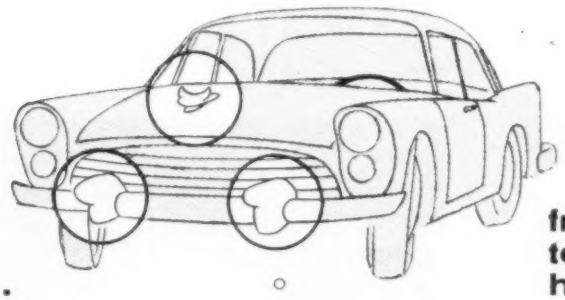
CIRCULAR TOOL CO., INC.
PROVIDENCE 5, RHODE ISLAND
Specialists in Circular Cutting Tools Since 1920

FOR FURTHER INFORMATION, USE READER SERVICE CARD; INDICATE A-12-131

HY-PRO specialists will show you how a little difference in design can deliver

100 times longer tap life

The jobs where tap life can be increased a hundredfold are obviously exceptional, but it *can* happen, as these cases prove, even in the cost-wise automobile industry. That's why it pays to question tap costs on any job. Job analysis by HY-PRO specialists *regularly* leads to savings as high as 50% — with special taps when required — but often with a simple switch to the right style of standard taps. Why not find out if your tap costs are low as they can be? It costs nothing to consult the HY-PRO specialists.



from 100 to 10,000 holes per tap...

The standard spiral point tap formerly used for tapping an automobile bumper bracket lasted for 100 holes or less, due to breakage. The cause was misalignment which could not be corrected without prohibitive expense for jigs, and for special controls in preceding operations. HY-PRO specialists designed a no-flute, 3-spiral groove tap with special heat-treatment which boosted production to 10,000 holes per tap — with no change in job conditions. Result . . .

98% SAVINGS in tap cost

from 25 to 10,000 holes per tap...

In a tapping operation on a die cast automobile ornament, the standard 3-flute tap being used broke after an average run of 25 holes. The cause was spalling and binding of the relatively soft alloy around the tap. HY-PRO specialists recommended an oversize 3-flute plug point tap with minor flute modifications. Binding was eliminated, and clean cut threads permitted easier assembly. Production was increased to 10,000 holes per tap. Result . . .

99% SAVINGS in tap cost

ASK FOR STOCK LIST OF SPECIAL TAPS AVAILABLE FOR IMMEDIATE DELIVERY

Why "special" tap development brings you better "standards"

Even though you never need "specials", you benefit by HY-PRO leadership in special tap design. The intensive research and testing involved is all reflected in constant improvement of HY-PRO standard taps. HY-PRO specialists can often point out opportunities for substantial savings, even in tapping operations you've considered satisfactory. For information, write: Dept. C.

The Tap Engineering Specialists

HY-PRO

REG. U. S. PAT. OFF.

HY-PRO TOOL COMPANY
DIVISION OF CONTINENTAL SCREW CO.
NEW BEDFORD, MASS., U.S.A.

CALL YOUR LOCAL **HY-PRO DISTRIBUTOR** FOR STANDARD TAPS FROM STOCK

Field Notes

Innovation in the field is the certification that Strategic Materials Corp. and Koppers Co., Inc. has announced for economic performance of integrated steel plants employing the Strategic-Udy direct iron reduction process. In a joint statement, presidents of the two companies said that the guarantee depends only on availability of reasonably priced electric power and advantageous location of raw materials. Willingness of the two firms to certify economic performance of the process is based largely on significant results obtained in a series of tests now being completed at a semi-works plant operated by Strategic Materials at Niagara Falls, Canada. In tests of standard shipping-grade iron ore, semi steel was produced in the Strategic-Udy patented electric furnace with a power consumption averaging 1200 kilowatt hours per ton of metal. In full size commercial plants engineering projections indicate that power consumption per ton would be reduced to 1000 kilowatt hours.

For three consecutive years, The Sheffield Corp. has conducted Manufacture and Measurement Clinics designed to give engineers an opportunity to see latest developments and techniques in precision measurement, cylindrical thread and form grinding, ultrasonic machining and precision gear grinding. The clinics are held at Dayton in conjunction with the Eli Whitney Metrology Laboratory.

Lectures, discussions, films, demonstrations and plant visitations cover such subjects as air gage circuit design and tooling, multiple inspection gaging, gyro, gimble and servo inspection, automatic gaging, automatic assembly machines, thread rolling and cutting, thread and form grinding processes, ultrasonic machining for production and research, etc.

new activities

A boring and reaming tool manufacturing firm, identified as Muskegon Tool Industries, Inc., has been formed in Muskegon, Mich. Production has started of tools similar to those formerly produced by Madison Industries, Inc. according to officers of the new firm. Head of the new company is Warren E. Gill, formerly president of Madison Industries.

V V V

Alpine Electronic Components Corp. has been formed in Waterbury, Conn. for manufacture of components and parts for the electronics field. President of the new company is Thomas E. Rowlison.

V V V

Narda Hydraulics Corp. has been formed as a subsidiary of The Narda Microwave Corp. The new firm will engage in design, manufacture and marketing of hydraulic components, pre-oilers and preservation machines, and specialized test equipment for aircraft, automotive, oil and machine tool industries. It will be located at 122 Herricks Rd. in Mineola, N. Y., adjoining headquarters of the parent company.

new facilities

Jones & Laughlin Steel Warehouse Div. has opened new warehouse facilities in Louisville, Ky. at 6901 Preston Hwy. The new facility includes more than 100,000 sq ft of floor area to allow an expansion of stock items as well as the inclusion of new items of flat rolled steel, stainless steel and aluminum.

V V V

New warehouse and sales offices have been opened by K S M Products, Inc. at 656 Folsom St. in San Francisco. In addition to maintaining a complete line of new equipment, parts and a full line of studs, the office will supervise and service stud welding accounts for central and northern California areas as well as activities in Washington and Oregon.

V V V

A branch sales office for Pesco Products Div. of Borg-Warner has been established in New York City to provide faster service to eastern plants.

V V V

Pratt & Whitney Co. Inc. opened a new distribution warehouse in Cleveland, Ohio. The 4000-sq ft building was constructed adjoining the company's Sterling Die Div. plant. The facility will stock standard cutting tools and conventional gages to fill requirements of P&W local stores and distributors outside of New England, Eastern New York, New Jersey and Pennsylvania.

V V V

Completion of a new building to house Dreis & Krump Mfg. Co. has been announced. The 55 by 300-ft building will meet the increasing need for more assembly space.

V V V

A recently completed building at 340 Roebling Rd., South San Francisco, Calif. is the new home of John A. Roebling's Sons Corp. The facility marks another step in the corporation's program of expanding its sales, warehousing and assembly facilities.

V V V

Open house marked establishment of the Titeflex-Pacific Div., first branch plant of Titeflex, Inc. The new facilities, located at 2328 Broadway in Santa Monica, Calif. is a 15,000-sq ft plant to house manufacturing, engineering, assembly, warehouse and Los Angeles district sales offices.

trade associations

National Institute of Jig and Fixture Component Manufacturers was founded October 1 as a national, nonprofit trade organization. At the organizational meeting in Los Angeles, Erick W. Bergmann of Monroe Engineering Products, Inc. was elected president; John Burke of West Point Mfg. Co. became vice-president; and Harold Wrigley of Vlier Engineering Corp. was made secretary-treasurer. Mr. Wrigley is a member of ASTE's Santa Monica Bay chapter.

V V V

Reorganization of the Solid Carbide Tool Institute took place at the organization's October meeting in Chicago. The new institute proposes to provide standards on solid carbide tools for the industry, and will develop and publish statistical information for its members. New president of the organization is Herbert W. Fichtner of the Atrax Co.

moves

Executive sales offices of The Colson Corp. have been moved to 7 S. Dearborn St. in Chicago.

V V V

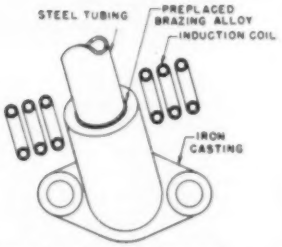
Manufacturing and administrative facilities of The Mettler Co., Inc., a division of Eclipse Fuel Engineering Co., were moved from Los Angeles to Rockford, Ill. The move will make additional manufacturing space available

The Lepel Line of induction heating equipment represents the most advanced thought in the field of electronics as well as the most practical and efficient source of heat yet developed for industrial heating.

If you are interested in induction heating you are invited to send samples of the work with specifications. Our engineers will process and return the completed job with full data and recommendations without any cost or obligations.

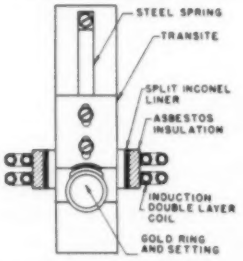
TYPICAL INDUCTION HEATING APPLICATIONS

IRON CASTINGS BRAZED TO STEEL TUBES



Assembly of iron castings and steel or copper parts are facilitated by induction heating. Arrangement is illustrated for silver brazing malleable iron castings to steel tubing. Coil design shown provides uniform heating for joint. Proper joint design assures high bond strength. Electrolytic treatment of castings to remove carbon (Kolene Treatment increases strength and tightness of joint to gases and liquids.

GOLD BRAZING IN JEWELRY INDUSTRY



Liner type induction coil shown provides a flexible arrangement for brazing settings to gold rings. The simple fixture facilitates handling. The unique coil design permits heating by induction and by radiation from heated metal liner. Ring, setting and gold brazing alloy are pre-assembled in a ceramic jig and then moved into heating position within the coil for brazing.

CUTTER BLADES SELECTIVELY HARDENED

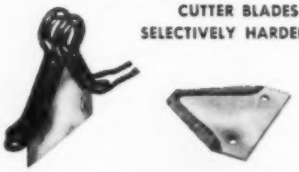


Photo shows coil design and arrangement used to selectively harden edges of cutter blades used in agricultural equipment. In production, cutter blades are automatically fed between layers of the induction coil, selectively heated and then oil quenched at the rate of one per second. Hardness at the cutting edge is Rc 62/64. Distortion is negligible.

Electronic Tube Generators from 1 kw to 100 kw.
Spark Gap Converters from 2 kw. to 30 kw.

WRITE FOR THE NEW LEPEL CATALOG . . . 36 illustrated pages packed with valuable information.

All Lepel equipment is certified to comply with the requirements of the Federal Communications Commission.

LEPEL HIGH FREQUENCY LABORATORIES, INC.
55th STREET and 37th AVENUE, WOODSIDE 77, NEW YORK CITY, N. Y.

FOR FURTHER INFORMATION, USE READER SERVICE CARD; INDICATE A-12-134

for expansion in products and markets. Key executive, manufacturing and engineering personnel are moving to the new location.

V V V

Headquarters for Bryant gages and surface plates has moved from Springfield, Vt. to the Ex-Cell-O plant in Greenville, Ohio. Bryant Chucking Grinder Co. was acquired by Ex-Cell-O earlier this year through an exchange of stock. There is no change in the Bryant sales staff or dealer organization.

anniversary

A half century of activity in the lubrication field is being celebrated by Acheson Colloids Co. Originally founded as the Acheson Oildag Co. in Niagara Falls, N. Y. in 1908 by Dr. Edward Goodrich Acheson, who developed Aquadag (a dispersion of colloidal graphite and water) in his private laboratory, the company now maintains three modern laboratories for developing and maintaining new and improved products.

expansions

A major expansion program now under way at Vanadium-Alloys Steel Co. includes installation of new office equipment designed to speed up paperwork involved in servicing of customer orders.

V V V

A 60 percent increase in floor space will be provided by the plant expansion at Bendix Industrial Controls Section of Bendix Aviation Corp. The new manufacturing facility will be located next to the company's main plant at 21820 Wyoming Ave. in Detroit. Majority of the expanded plant space will be devoted to manufacture of machine control units for automatically controlling machine tools in machining complex parts.

acquisitions

All design, manufacturing and sales rights to the line of Packmaster automatic packaging machinery were acquired by Sundstrand Machine Tool Co. Machines in the new Sundstrand-Packmaster line will be built and sold through the American Broach Div. in Ann Arbor, Mich.

V V V

Landis Tool Co. acquired all shares of stock of John Lund Ltd., a British company that manufactures grinding and fine boring machines. The new British subsidiary will continue its present lines and also manufacture special and semispecial grinding machines now produced by Landis and its subsidiary,

THE TOOL ENGINEER'S *Service Bureau*

TRADE LITERATURE CURRENTLY OFFERED BY THE TOOL ENGINEER ADVERTISERS

A-12-216-3—Drill Bushings—*Acme Industrial Co.* Free drill bushing selector now available. (Page 216)

A-12-182-2—Air Cylinders—*A. K. Allen Co.* Thirty-seven-page catalog illustrates complete line of air cylinders, valves and clamps. (Page 182)

A-12-8—Lathes—*The American Tool Works Co.* Bulletin No. 135 gives complete description of the "American" deluxe model hydraulic duplicating lathe. (Page 8)

A-12-195—Air Cylinders—*The Bellows Co.* Bulletin BM-25 gives complete details on the Bellows air motor. (Page 195)

A-12-35 — Grinders — *Besly-Welles Corp.* Details of DH4 grinders given in bulletin DH4. (Page 34-35)

A-12-123—End Mills—*Cutting Tool Div., Brown & Sharpe Mfg. Co.* Nelco catalog describes complete line of carbide cutting tools. (Page 123)

A-12-148—Rivets—*Chicago Rivet & Machine Co.* Engineering data, types of rivets and details of automatic rivet setters available in new catalog. (Page 148)

A-12-131—Circular Saws—*Circular Tool Co., Inc.* Information on metal-cutting saws in Catalog O. (Page 131)

A-12-147—Optical Grinder—*The Cleveland Grinding Machine Co.* Free brochure describes capabilities of visual grinding machine for contour precision grinding. (Page 147)

A-12-184-3 — Milling Arbors — *Donley Products, Inc.* New data sheets have case histories of actual company performance reports on jobs. (Page 184)

A-12-206—Drill Units—*The Dumore Co.* Details on drill units now available. (Page 206)

A-12-33—Gages—*Federal Products Corp.* Free catalog illustrates complete line of dial indicator gages. (Pages 32-33)

A-12-168—Broaching Machines—*The Foote-Burt Co.* Circular No. 503 gives information on surface broaching machines. (Page 168)

A-12-115 — Microscopes — *The Gaertner Scientific Corp.* Bulletin 147-56 shows applications, models and specifications of various microscopes. (Page 115)

A-12-145 — Hydraulic Cylinders — *Nopak Div., Galland-Henning.* Complete data and dimensions on hydraulic cylinders described in Catalog 103. (Page 145)

A-12-121—Milling Machines—*Greaves Machine Tool Co.* Free comparison chart and detailed descriptive literature on milling machines and attachments available. (Page 121)

A-12-112—Bar Machines—*Greenlee Bros. & Co.* Catalog A-405 gives information on Greenlee Air-Feed automatics. (Page 112)

A-12-150 — Electrolytic Grinder — *Hammond Machinery Builders, Inc.* Catalog gives information on chip breaker grinders and combination oscillating and chip breaker grinders. (Page 150)

A-12-5—Lathe—*Hardinge Bros., Inc.* Toolroom Model HLV Lathe described in Bulletin HLV. (Page 5)

A-12-199-1 — Ballizing — *Industrial Tectonics, Inc.* Sixteen-page bulletin gives information on equipment and prices. (Page 199)

A-12-176—Milling Cutters—*Cutters Div., The Ingersoll Milling Machine Co.* New book gives information about the Cutter Div. grinding service. (Page 176)

A-12-111—Progressive Dies—*The B. Jahn Mfg. Co.* Brochure shows products of B. Jahn Co. (Page 111)

A-12-166-1—Tachometer — *Jones Motrola Corp.* Information on hand tachometers available in Catalog 146. (Page 166)

A-12-134—Induction Heating Units—*Lepel High Frequency Laboratories, Inc.* New 36-page illustrated catalog gives information on Lepel equipment. (Page 134)

A-12-159—Hydraulic Cylinders—*Logansport Machine Co. Inc.* Free Logan calculator simplifies air and hydraulic cylinder design. (Page 159)

A-12-21—Circular Saws—*Motch and Merryweather.* Free copy of M&M's circular sawing handbook is pocket-sized guide to sawing operations. (Page 21)

A-12-146—4-Slide Machines—*The A. H. Nilson Machine Co.* The Vertiform horizontal 4-slide machine illustrated in general catalog on automatic 4-slide equipment. (Page 146)

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TRADE LITERATURE CURRENTLY OFFERED BY THE TOOL ENGINEER ADVERTISERS

A-12-117—Pressure Regulator—*C. A. Norgren Co.* Descriptive literature gives data on pressure regulators for air and non-corrosive gases. (Page 117)

A-12-36—Induction Hardening—*The Ohio Crankshaft Co.* Free booklet "Typical Results of Tocco Induction Hardening and Heat Treating" available. (Page 36)

A-12-180 — Grinding Machines — *Olivetti Corp. of America, Machine Tool Div.* Illustrated, 22-page catalog available on precision grinding machines. (Page 180)

A-12-182-1—Optical Dividing Heads—*Opto-Metric Tools, Inc.* Catalog 82-1 describes the Leitz optical dividing head. (Page 182)

A-12-158—Cylinders—*Ortman-Miller Machine Co.* Catalog 101A contains engineering data on air and hydraulic cylinders. (Page 158)

A-12-185—Brakes—*Pacific Industrial Mfg. Co.* Brochure describes the uses of Pacific hydraulic press brakes. (Page 185)

A-12-193—Aluminum Tooling Plate—*Pioneer Aluminum Co.* Complete description of Pioneer 921-T-DC aluminum tooling and applications contained in new brochure. (Page 193)

A-12-15—Punch Units—*Punch Products Corp.* Free methods book gives basic facts on unitized tooling with Unipunch. (Page 15)

A-12-200—Turning Tools—*R and L Tools.* New catalog available on complete line of cutting tools and holders. (Page 200)

A-12-156—Punches and Dies—*Ring Punch & Die, Inc.* Illustrated catalog 105 shows complete line of standard punches and dies. (Page 156)

A-12-155—Angular Tooling Equipment—*Omer E. Robbins Co.* Complete range and models of magnetic sine "Magnasine" inspection sine plates and heavy-duty sine plates shown in new catalog. (Page 155)

A-12-114—Clutches—*Rockford Clutch Div., Borg-Warner.* Typical installations show Rockford clutches and power take-off with diagrams. (Page 114)

A-12-120—Carbide-Tipped End Mills—*Sandvik Steel, Inc.* Folder gives complete data on all sizes of Coromant mills. (Page 120)

A-12-212—Tap Driver—*Scully-Jones and Co.* Bulletin No. 20-50 gives engineering data on Scully-Jones reversible safe-torque tap driver. (Page 212)

A-12-166-2—Lathes—*Sheldon Machine Co., Inc.* New catalog describes cost cutting advantages of Sheldon Sebastian lathes. (Page 166)

A-12-19 — Boring Machine — *Sundstrand Machine Tool Co.* Fifteen-hp Omnimil and 50-hp vertical Rigidmil described in Bulletin 798. (Pages 18-19)

A-12-204-3—Adjustable Drillheads—*Thriftmaster Products Corp.* Complete information available on eccentric adjustable drillhead. (Page 204)

A-12-205-2—Balancing Machines — *Tinius Olsen Testing Machine Co.* New Rava electrodynamic balancing machines described in Bulletin 56. (Page 205)

A-12-14—Tool Steel—*Uddeholm Co. of America, Inc.* New tool steel Stock list No. 12 now available. (Page 14)

A-12-213—Adjustable Drill Heads—*United States Drill Head Co.* Catalog AD-57 describes the standard sizes of adjustable drill heads. (Page 213)

A-12-23—Plastic Tooling—*United States Gypsum.* Informative bulletins available on Hydrocal-Ultracal cements and Epoxical plastic tooling resins. (Page 23)

A-12-152—Collet Chucks—*Universal Engineering Co.* New catalog shows complete line of Universal collet chucks. (Page 152)

A-12-192-2—Tube Benders—*Wallace Supplies Mfg. Co.* Thirty-six-page booklet shows use of benders in plants. (Page 192)

A-12-178-1—Perforating Dies—*S. B. Whistler & Sons, Inc.* New catalogs give complete details on Magna-Die and Adjustable Die. (Page 178)

A-12-182-5—End Mills—*Woodson Tool Co.* Catalog gives data on micro miniature end mills. (Page 182)

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Gardner Machine Co. Name of the British firm now will be changed to Landis-Lund Ltd. with operations continuing under the same managing director.

v v v

Black & Webster, Inc. has purchased all capital stock of Edward Blake Co., Inc. According to the announcement, no change is contemplated in any of the policies of the Blake Co. Former owner and president Edward Blake will remain actively associated with the firm as a consultant.

license agreements

Exclusive world-wide licensing rights to the electrothermal process for single-step reduction of metallic oxides has been acquired from Electro-Thermal Industries, Inc., developers of the process, by Hydrometals, Inc., formerly Illinois Zinc Co. Hydrometals' two-phase marketing plan calls for granting of sublicenses for use of the process to metal industries throughout the world, and for establishing its own facilities for production of selected metals and alloys.

v v v

Swiss-designed industrial gears providing unusually precise tolerances are being made available in the United States through an agreement between The Philadelphia Gear Corp. and Maag Gear-Wheel Co. Ltd. of Zurich, Switzerland. Philadelphia Gear now becomes exclusive agent for manufacture and sale of Maag gear products in the United States and territories.

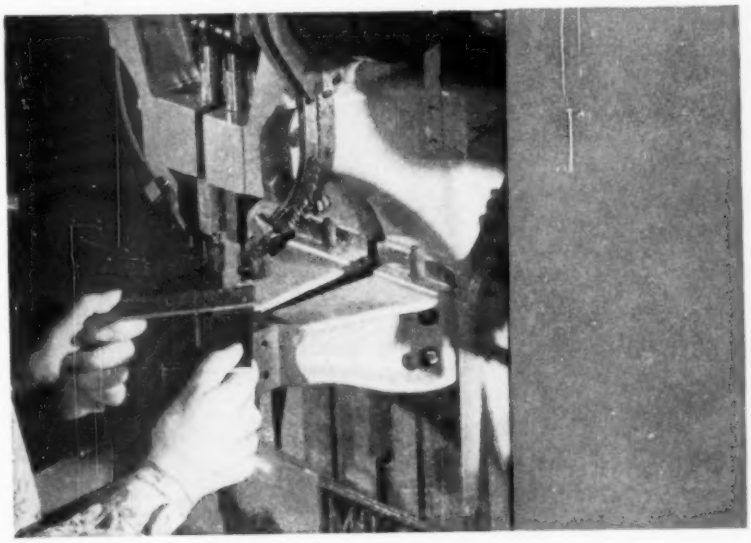
mergers

A multimillion dollar merger of engineering companies came about with acquisition of all assets of Wettlaufer Engineering Corp. by Pioneer Engineering & Mfg. Co., Inc. Wettlaufer will be reorganized into an operating division. According to its president, Michael Pinto, the new engineering organization can carry product ideas through all of the engineering phases of design and development down to fabrication of actual jigs, fixtures and tools needed to make the product.

v v v

The Plastics Div. of Ciba Co. Inc. has been merged with its manufacturing affiliate, Ciba Products Corp. which now will be headquarters for all Ciba management sales and technical services personnel for Araldite epoxy resins. The company will continue to make its headquarters in Kimberton, Pa. until new research and production facilities are completed in Toms River, N. J., and its administrative and sales offices are transferred to new quarters in Fair Lawn, N. J.

CUT UNIT ASSEMBLY COSTS . . .
GET HIGH-SPEED, LOW-COST FASTENING . . .
TAKE ADVANTAGE OF AUTOMATIC ASSEMBLY



Milford shows you how to cut assembly costs!

Tubular rivets are basically a low-cost fastener. Feed and clinch them with automatic Milford Riveters, and you *multiply* the cost savings inherent in rivets.

The Milford Riveter shown here is only one of a full line of automatic machines. Bench or floor models . . . single or multiple spindle . . . manual or automatic, the Milford Riveter line is designed to solve your toughest assembly problems.

Remember . . . these are *basic* rivet-setting machines. They can be tooled quickly and inexpensively for your particular assembly needs. And it's up to you whether you buy or lease. For a complete line of fasteners . . . for fast, trouble-free assembly—look to Milford first!

MODEL 220-BH

RIVET CAPACITY: 1/32" dia. by 1/8" length to 9/64" dia. by 1/4" length.
THROAT DEPTH: 11"
POST HEIGHT: From 0" to 18"
HOPPER: Rotary
CLUTCH: Single trip, non-repeating Horton type
FLYWHEEL: 260 R.P.M.
DRIVE: V-belt noiseless

MODEL 220-BH

THE MILFORD RIVET
MILFORD RIVET & MACHINE CO.
MILFORD, CONNECTICUT • HATBORO, PENNSYLVANIA
ELYRIA, OHIO • AURORA, ILLINOIS • NORWALK, CALIF.

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ECCENTRICITY 0.0002" maximum
TOTAL Composite Error 0.00025" maximum
DO YOUR GEARS NEED TO BE MADE TO THESE SPECIFICATIONS ?
GEAR ILLUSTRATIONS ACTUAL SIZE
...then go
MIKRON
NO. 132-01 MIKRON SPUR GEAR HOBBING MACHINE

Ask for our Bulletin RH-132-01 which describes the new MIKRON 15-Second Spacing Accuracy Machine.

RUSSELL, HOLBROOK & HENDERSON, INC.

292 Madison Avenue, New York 17, N. Y.

Men at Work

Ralph J. Kraut, president of Giddings & Lewis Machine Tool Co., was elected president of the National Machine Tool Builders' Assn. He also is a member of ASTE's Fond du Lac chapter.

Glenn B. Warren was elected president of The American Society of Mechanical Engineers. He is vice-president and consulting engineer of the turbine division of General Electric Co.

Herchel M. Richey is new vice-president in charge of manufacturing for the Roller Bearing and Rock Bit Divs. of The Timken Roller Bearing Co. replacing A. M. Donze who retired.

ROBERT B. HEPPENSTALL, JR. was elected a vice-president of Heppenstall Co. He now assumes executive responsibility for manufacturing, engineering and sales of the company's four plants.

Officers elected by NMTBA to support new President Kraut include ALLAN C. MATTISON, president of Mattison Machine Works as first vice-president; EVERETT M. HICKS, vice-president and general manager of Grinding Machine Div. of Norton Co., second vice-president; and GRAHAM E. MARX, vice-president and general manager of The G. A. Gray Co., treasurer. WALTER K. BAILEY, president of The Warner & Swasey Co., was re-elected treasurer. Mr. Bailey belongs to ASTE's Cleveland chapter.

Firth Sterling Inc. appointed W. W. WELLBORN technical director, Carbide Div. Formerly manager of new products research, he now assumes responsibility for process metallurgy and metallurgical aspects of quality control in the division.

At A. Schrader's Son Div. of Scovill Mfg. Co., Inc., GARVIN A. DREW has been named general manager. For the past 18 years he served as general sales manager of Schrader, and in 1954 was appointed a vice-president of Scovill.

Another executive change made by the Scovill board of directors was the appointment of Schrader's operations manager, RUSSELL C. FLOOD, as a vice-president of Scovill. He will continue his duties as operations manager.

Republic Gear Co.'s board of directors has named STEVEN S. GORDON president of the firm. He formerly was vice-president and general manager, carrying out the functions of president.

CLIFFORD A. SHARPE is now senior vice-president of American Bosch Arma Corp. Prior to this appointment he was vice-president of operations, a post he had held since May 1954.

The company also has named ERNEST A. GOETZ as technical assistant to the president. Mr. Goetz also will remain chief engineer of Arma Div., a post he has held since May 1957.

GEORGE GUMAS was appointed vice-president in charge of engineering at CDC Control Services, Inc. He will be responsible for production of control systems, development of new control techniques and scheduling of all engineering work.

At the recent annual meeting in Boston, the American Machine Tool Distributors' Assn. elected J. O. ELLISON, president of Harron, Rickard & McCone Co. of Northern Calif., president for the coming year. He also is a member of ASTE's Golden Gate chapter. Serving with new President Ellison will be J. RUSSELL CLARK, president of White Star Machinery & Supply Co., Inc., as first vice-president; GEORGE E. MERRYWEATHER, vice-president and secretary of Motch & Merryweather Machinery Co., as second vice-president; and I. B. RABEL, president of Star Machinery Co., as secretary-treasurer.

Seldon T. Williams, general manager of A. Schrader's Son Div. of Scovill Mfg. Co., has been elected president and general manager of Scovill to succeed retiring William M. Goss.

Donald R. Spotz was promoted from vice-president and general sales manager to the post of president and general manager of Pesco Products Div. and Wooster Div., Borg-Warner Corp.

William J. Stewart, a veteran of 40 years of service at The Cleveland Punch & Shear Works Co., is new president of the company. He previously was vice-president and general manager.

F. B. Wilkinson, formerly vice-president of Logansport Machine Co., Inc., was elected president to succeed Mrs. E. P. Wilkinson who was made chairman of the board of directors.

Gray Iron Founder's' Society elected ALBERT M. NUTTER president of the organization at its recent annual meeting in Washington D. C. He is treasurer of E. L. LeBaron Foundry Co. Other newly elected officers are J. E. QUEST, president of Quest Mfg. Co., vice-president; and WILLIAM A. HEPBURN, vice-president and treasurer of John T. Hepburn, Ltd., secretary.

Directors of Ess Instrument Co. elected RAYMOND W. HEIMSOTH president of the firm. Vice-president and chief engineer for the past ten years, he now succeeds Col. C. C. SHEPPARD who retired.

At the same time, the company named EUGENE ROSS vice-president in charge of sales.

Appointments at Hydreco Div. of The New York Air Brake Co. involved CLARE ENGLE, who became superintendent of manufacturing, and GEORGE DIGGLES, who now is manager of production engineering. Mr. Engle has been general superintendent of the Outboard Div. of Oliver Corp. Mr. Diggles has been with Air Brake for a number of years in various supervisory capacities.

Appointment of W. S. HYLER as technical assistant to the vice-president of research was announced by Huck Mfg. Co.

Dana Corp. has announced appointment of WILSON T. GROVES as chief metallurgical engineer succeeding S. L. WIDRIG who retired.

At its annual meeting, the Porcelain Enamel Institute elected ROBERT N. SMITH, vice-president of Temco, Inc., to serve as president for a two-year term of office. He succeeded James W. Vicary, president of Ervite Corp., who was elected chairman of the board.

PHILLIP W. SCOTT was elected group vice-president of The Budd Co. with supervision over four of the company's divisions. He has been administrative vice-president of the Byron Jackson Div.

Five vice-presidents were elected by ASME to serve with new president Warren. They include CHARLES H. COOGAN, JR., head of the mechanical engineering department of the University of Connecticut, GORDON R. HAHN, assistant chief mechanical engineer for Gibbs and Hill, JOHN W. LITTLE, president of Goslin-Birmingham Mfg. Co., THOMAS J. DOLAN, head of the department of theoretical and applied mechanics at the University of Illinois, and HAROLD GRASSE, partner in Black and Veatch.

Two new vice-presidents have been elected for The Siegler Corp. DAN W. BURNS earlier this year was named president of The Hufford Corp., a Siegler subsidiary. ROBERT T. CAMPION will also continue in the post of secretary of the corporation which he has held since 1957.

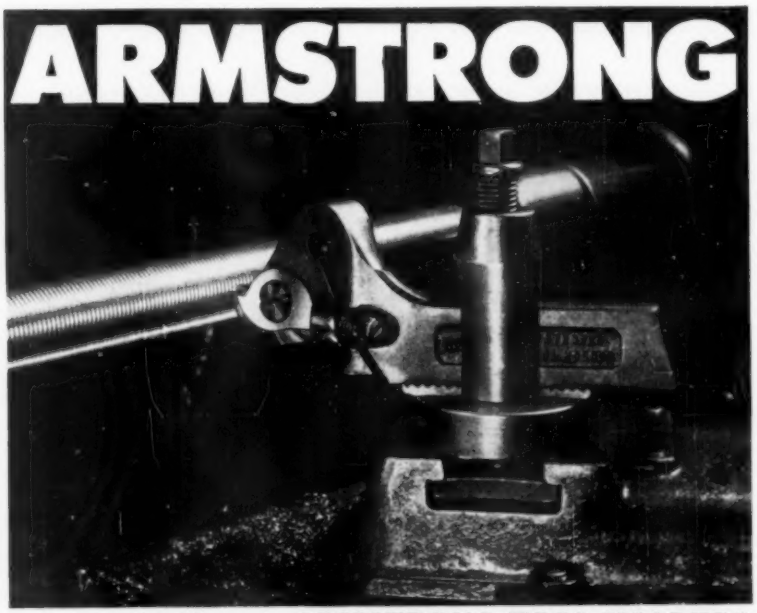
EDWARD C. LINDSAY was appointed vice-president in charge of manufacturing for the Hufford Corp., a division of The Siegler Corp. Prior to joining Siegler, he was vice-president of engineering sales for Mercury Engineering.

At Kenco Mfg. Co., ROBERT LINVILLE was made vice-president in charge of marketing. He formerly was vice-president in charge of sales for The Burgmaster Corp.

A. N. HAIG is now engineer-in-charge, sales and engineering, of a newly formed accellerator section in the motor and generator department of Allis-Chalmers. He has been associated with the company since 1948.

Apointment of ROBERT W. KEENAN as manager of production planning and control was announced at Sharon Steel Corp. He has been assistant manager of the department.

The engineering department of The Barden Corp. has announced three appointments. LEWIS W. MCKEE, formerly assistant chief engineer-product, was made chief product engineer. JOHN J. MURPHY, who was research coordinator, was named contract research manager. KENNETH D. MACKENZIE, formerly associated with the New Departure division of General Motors Corp., has joined Barden as advanced product manager.



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Trade Literature

for free booklets and catalogs—use request card, page 135

Industrial Scale Models

"Designing in 3-D" catalog contains descriptions and instructions for assembling thousands of parts and materials used in building industrial scale models, so that the average designer or draftsman can build such models quickly and easily, and see finished design in miniature before he begins details of drafting. Scott Industries, Inc., Olean, N.Y. **L-12-1**

Aluminum Bronze Alloys

Extensively illustrated 12-page Bulletin Pl-5a describes various Ampco alloys, discusses their characteristics, uses and advantages and tabulates their physical properties; also explains the techniques for welding these alloys and the results. Ampco Metal, Inc., Milwaukee 46, Wis. **L-12-2**

Screw Thread Standards

Vol. V, No. 1 of *H & G Die Headlines* contains article on "Unified and American National Screw Thread Data" which is a digest of thread standards and presents major, minor and pitch diameters giving classes, allowances and tolerances of all internal and external threads up to and including 2 in. The Eastern Machine Screw Corp., Truman & Barclay Sts., New Haven 6, Conn. **L-12-3**

Honing

Sixteen-page "Typical Applications" booklet gives production rates, size, tolerance, stock removal and finish data on 99 case histories; widely diversified parts from $\frac{1}{8}$ to $2\frac{3}{4}$ in. ID; illustrated with photos. Sunnen Products Co., 7910 Manchester Ave., St. Louis 17, Mo. **L-12-4**

Angle Conversion Chart

Wallet-size conversion chart quickly shows conversion of small angles (from one second to one minute) to microinches per inch, per 10 inches and per foot; and linear measure from one microinch to 0.005 inch in terms of minutes, seconds and fractional seconds, per inch, per 10 inches and per foot. Engis Equipment Co., 431 S. Dearborn St., Chicago 5, Ill. **L-12-5**

Air Cylinders

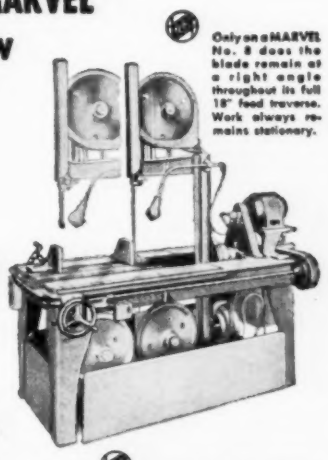
Illustrated with dimensional and cross section drawings, 24-page Catalog No. SA7 presents line of square air, air-draulic, air booster and low pressure hydraulic air cylinders. Tab indexed for convenience. Lynair Inc., 3100 E. Michigan, Jackson, Mich. **L-12-6**

Press Dies

Illustrated leaflet, Bulletin No. AFD-958, offers complete information on Alloy-Form dies for bending and forming alloy sheets and plates and which will fit any make of press brake. Dries & Krump Mfg. Co., 7400 S. Loomis Blvd., Chicago 36, Ill. **L-12-7**

Never Confuse the No. 8 MARVEL with an ordinary Band Saw

...only the MARVEL is Universal



Only on a MARVEL No. 8 does the blade remain at a right angle throughout its full 18" feed traverse. Work always remains stationary.

Only on a No. 8 MARVEL can the saw column be instantly indexed and locked at any angle from 45° right to 45° left, and the saw then fed thru the work at the desired angle — without moving the work.

Only a No. 8 MARVEL can do all of these things: Snip-off a ½" rod or cut-off an 18" x 18" cross section.

Rough to Size and Shape

Miter

Index

cut off and shape Structural Beams

Slotting

Only a No. 8 MARVEL has the large T-slotted work table, with removable quick action vise, that permits accurate set-ups of work of unrestricted sizes and shapes, special fixtures; Etc.

"Rough Machine" to size and shape with minimun chip waste

The No. 8 MARVEL is the "busiest tool in the shop" wherever installed because it is a *universal* tool—has both the capacity and the versatility to handle not only standard sawing jobs but innumerable "trick" and convenience jobs as well. More than a metal saw, the No. 8 MARVEL is a fine machine tool with machine tool features like: Both power and hand feeds; Depth Stops; Automatic Blade Tension; Built-in Coolant Pump; Three operating speeds (or six with 2-speed motor). Moisture-proof electrical controls that conform to both "J.I.C." and "MACHINE TOOL" electrical standards; Dirt-proof ball bearings, etc.

If you cut, machine or fabricate metal, this is a sawing machine you should know about. Write for catalog.

MARVEL Metal Cutting SAWS
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A MEASURE OF PERFECTION

Hanson-Whitney measures gage perfection by the exacting specifications established in H28 Handbook for Screw Thread Standards. These standards assure you of rigid accuracy controls on critical gaging elements, such as *size . . . lead . . . drunkenness* and *angle.*

In addition to this assured quality, you get extra wear life . . . achieved by Hanson-Whitney's "*finished after hardening*" Process. Quality materials, plus finished, lapped surfaces after grinding, produces gages that are truly a "measure of perfection."

Hanson-Whitney offers AGD Cylindrical and Thread, in steel and carbide, National and Unified thread series . . . special thread forms, Acme, Buttress, Round and others made to specifications. Hanson-Whitney also provides a complete line of Internal and External Thread Comparators.

Consult Hanson-Whitney's home and field engineers for practical, *one source* assistance on all threading and gaging problems. H-W Stocking Distributors across the country provide complete service.

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Switches

Descriptive Catalog Number CEI-602 covers complete line of miniature, precision pressure switches; illustrates and describes altitude, differential, gage and absolute types and provides application and installation data in both descriptive and tabular form. Dept. TE, Century Electronics & Instruments, Inc., 1333 N. Utica, Tulsa 10, Okla. **L-12-8**

Metal Coating

Series of case histories offers information on how most metals can be coated without pretreatment. Industrial Finishes Co., Inc., 1119 Land Title Bldg., Broad and Chestnut Sts., Philadelphia 10, Pa. **L-12-9**

Fasteners

Twelve-page Catalog 1959 presents line of clamp assemblies, fixture details, spring plungers and torque screws with dimensional drawings, size lists and prices for each type. Siewek Tool Co., 2862 E. Grand Blvd., Detroit 2, Mich. and 1649 S. La Cienega Blvd., Los Angeles 35, Calif. **L-12-10**

Cylinders

Discussion of important features of square design cylinder and comparison of it with other types is incorporated in catalog sheet which also contains drawings comparing mounting space required for various bore square type 4-tie-rod design cylinders with similar bore sizes of common threaded or keeper ring type cylinders. Miller Fluid Power Div., Flick-Reedy Corp., 2040 N. Hawthorne Ave., Melrose Park, Ill. **L-12-11**

Gas Welding and Cutting

Thirty-two page, extensively illustrated Catalog 586 covers all phases of gas welding and cutting; includes descriptions of welding torches and tips, cutting torches and tips, regulators, and welding and cutting accessories; also presents specification sheets to meet all types of gas welding and cutting requirements. Harris Calorific Co., 5501 Cass Ave., Cleveland 2, Ohio. **L-12-12**

Tumbling

Informative 20-page brochure, "Tumbling Media for Barrel Finishing", designed as practical handbook for supervisors and operators, discusses kinds of tumbling media, types of applications; types and functions of tumbling barrels, fixturing and linings for tumbling barrels; compounds and cleansers, do's and don'ts on use of water; and analyses of typical tumbling jobs; illustrated. The Carborundum Co., Electro Minerals Div., Niagara Falls, N.Y. **L-12-13**

Metal, Ceramic Coatings

Basic characteristics and properties plus range of mechanical and electrical-electronic applications for wire and powder sprayed coatings of metals and ceramics described in illustrated 8-page Bulletin 136A; tabulated data covers spraying speeds, material and gas consumption and square feet covered per hour with various types of metals and ceramics. Metallizing Engineering Co., Inc., Westbury, L.I., N.Y. **L-12-14**

Optical Instruments

Engineering data on Norelco electron optical instruments presented in well illustrated 16-page Booklet RC 178A; outlines principal features and discusses advantages, specifications, principles of operations and applications. Instrument Div., Philips Electronics, Inc., 750 S. Fulton Ave., Mount Vernon, N.Y. **L-12-15**

Butt Welding Rings

Twenty-two page booklet uses photos, drawings and charts to illustrate methods used to form bar stock by bending and explain how it is welded to produce rings used in industrial applications; discusses the specifications peculiar to flash butt welded rings, quality control procedures and testing. Also outlines in detail other services available to company's customers. The American Welding & Mfg. Co., Industrial Products Div., 454 Dietz Rd., Warren, Ohio. **L-12-16**

Screw Thread Metrology

Sixteen-page handbook reviews function and facilities of each of three SPS screw thread metrology laboratories; discusses various precision equipment needed for properly checking unified screw threads, tapered pressure plugs and special precision thread forms; appendix of reference material provides pertinent data on screw thread dimensions and tolerances from recently revised H-28 handbook; separate sections of booklet review in detail primary measuring devices, checking masters and comparison type working gages; well illustrated. Standard Pressed Steel Co., Jenkintown, Pa. **L-12-17**

Presses

Function and operating characteristics of two new manually controlled C-frame presses presented in 8-page illustrated Bulletin 58CPM, while similar information on four new automatic models of C-frame presses is presented in 12-page Bulletin 58CPA; both brochures include dimensional details, application data and descriptions of operating controls. The Hydraulic Press Mfg. Co., Div. of Koehring Co., Mount Gilead, Ohio. **L-12-18**

CONTROL the finish ...and the **COSTS** with the surfindicator

No over-finishing . . . no under-finishing with the Brush Surfindicator. Weighing only 15 lbs. and ready to be plugged into any 115 volt outlet, it provides on-the-job instant surface measurement. Controlled finish is now practical—inexpensive—and extremely profitable.

The Brush Surfindicator measures any surface—any shape—any size. Accurate measurements in microinches can be seen at a glance! It brings you laboratory-precision measurement unaffected by magnetic fields, vibration or line voltage variation. It requires no skill . . . can be used by anyone who can read a meter. Measurements are easily made in complete compliance with the new ASA and military standards. Write for the ASA standards and all of the complete facts on this profit-making tool that will pay for itself!

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Roll out the ROTORS

BG8-HT Rotor Grinder
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ROTOR GRINDING

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Completely automatic, the new Engelberg Model BG8-HT requires no manual operation. Rotors are automatically fed, precision sized and discharged in production quantities in a continuous cycle. Saves time, cuts rejects.

Check these production examples of the BG8-HT: 3⅜" O.D.; 2-up; 180 per hour (.030 stock removal from 2" stock.) 1-9/32" O.D.; 6-up; 1,440 per hour (.010 stock removal from ⅞" stock.)

Engelberg Model BG8-HT Features

★ Holds ± .001 diameter and within .0005 concentricity.

★ Hydraulically actuated feed movements, including table feed, oscillation, regulating wheel and belt tensioning.

★ Variable regulating wheel speeds to accommodate 1 to 4½" diameter range of rotors.

★ Automatic air-electric device provides constant in-process gauging, guaranteeing precision size control.

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Precision ABRASIVE BELT GRINDERS

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Drill Jig Bushings

Broad line of high-precision drill jig bushings described in Catalog 582 covering advance features in detail; all parts are catalogued according to a self-reading symbol system to simplify ordering and to make it easier to identify parts in inventory. Standard Bushing Manufacturers, Inc., 1487 Elmwood Ave., Providence 7, R.I. **L-12-19**

Lubricants

Lubrication Newsletter #5 publishes a technical paper covering effect of lubricants on "wear in" of new machinery; includes engineering study on surface geometry of mating surfaces and discussion of Coulomb's theory on friction as it applies to asperities on machined surfaces; also gives results of a continuing series of tests on lubrication of mating surfaces. Actual test records are pictured and analyzed. The Alpha-Molykote Corp., 65 Harvard Ave., Stamford, Conn. **L-12-20**

Steel Bars

All AISI grades of cold finished steel bars listed in 5-page 11 x 17-in. comparison wall chart; covers 241 grades of steel bars which satisfy more than 95 percent of all current manufacturers' specifications and outlines their complete chemical analysis; gives machinability ratings in surface feet per minute or as a percentage rating compared to AISI Grade B1112. La Salle Steel Co., P.O. Box 6800-A, Chicago 80, Ill. **L-12-21**

Coatings

Clear and colored coatings for use on metal, plastics, glass and wood presented in 36-page brochure; includes information on numerous types for application to various surfaces by spraying, screening and roller coating. Bee Chemical Co., 12933 S. Stony Island Ave., Chicago 33, Ill. **L-12-22**

Tubing

Eleven-page Data Memorandum No. 11 describes capillary tubing; gives definition materials from which it is produced, tolerances, finishes, special processing and inspection procedures, purposes and method of flow testing, and ordering information. Superior Tube Co., 1732 Germantown Ave., Norristown, Pa. **L-12-23**

Printed Circuit Drilling

Well illustrated with photos and drawings, 6-page folder, Bulletin 858, explains uses, advantages and important features of printed circuit boards to help simplify drawing, routing, cutting, etc. Zagar, Inc., 24000 Lakeland Blvd., Cleveland 23, Ohio. **L-12-24**

who's meeting and where

Dec. 7-9. The Material Handling Institute, Inc. Annual meeting. Roosevelt Hotel, New York City. Further details are available from meeting managers Hanson & Shea, Inc., One Gateway Center, Pittsburgh 22, Pa.

Dec. 10-12. The University of Wisconsin. Engineering institute on industrial plant maintenance. Pertinent data is available from Engineering Institutes, University Extension Div., The University of Wisconsin, Madison 6.

Jan. 7-9. The University of Wisconsin, University Extension Div. Engineering institute on industrial computer applications. Write to Engineering Institutes, University Extension Div., The University of Wisconsin, Madison 6.

Jan. 12-14. Reliability and Quality Control, Fifth National Symposium. Bellevue-Stratford Hotel, Philadelphia, Pa. For details, contact William R. Rombach, Philco Corp., 4700 Wissahickon Ave., Philadelphia 44, Pa.

Jan. 26-29. Plant Maintenance & Engineering Show, Public Auditorium, Cleveland. Complete information is available from Clapp & Poliak, Inc., 341 Madison Ave., New York 17, N.Y.

Feb. 3-5. The Society of the Plastics Industry, Inc., Reinforced Plastics Div. 14th annual technical and management conference, Edgewater Beach Hotel, Chicago. Society office, 250 Park Ave., New York 17, N.Y. can supply more data.

Feb. 6-7. University of California. 11th annual industrial engineering institute, to be conducted simultaneously on the Berkeley and Los Angeles campuses. Further information may be obtained from the Dept. of Conferences, University Extension, University of California, Berkeley 4 or Los Angeles 24, Calif.

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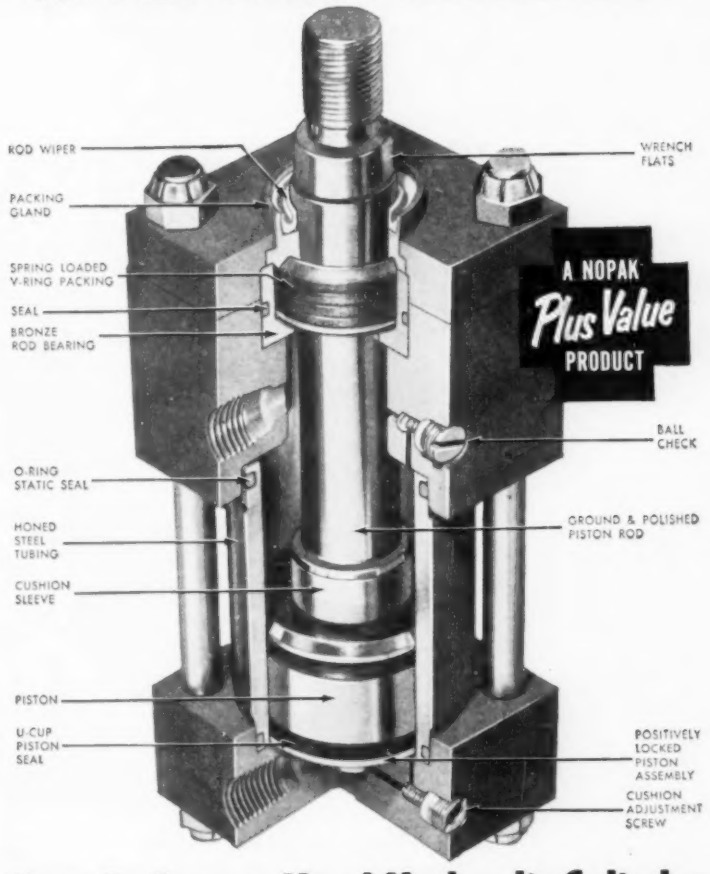

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Pressures 3,000 P. S. I. operating, 5,000 P. S. I. proof

Check these Class 3 Plus Values . . .

- Interchangeable with other well-known square head, hydraulic cylinders
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- 18 Standard mountings
- More power per dollar

Ask for Catalog 103 . . . It contains complete Data and Dimensions.

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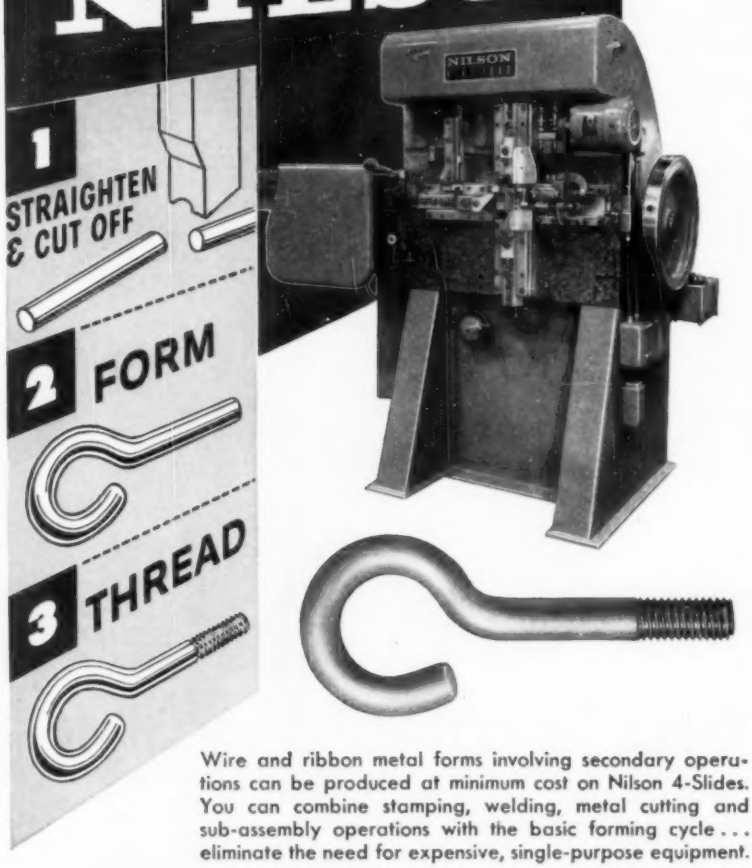

Wire and ribbon metal forms involving secondary operations can be produced at minimum cost on Nilson 4-Slides. You can combine stamping, welding, metal cutting and sub-assembly operations with the basic forming cycle . . . eliminate the need for expensive, single-purpose equipment.

The Nilson "Vertiform" shown above, for example, has a die head mounted on the right-hand forming slide. Wire stock is straightened, cut off, formed and threaded—all automatically in one cycle!

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AUTOMATIC WIRE & RIBBON METAL FORMING 4-SLIDE MACHINES • WIRE & STOCK REELS • WIRE STRAIGHTENING EQUIPMENT • AUTOMATIC STAPLE FORMING MACHINES • SPECIAL WIRE FORMING EQUIPMENT
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good READING

CONCISE GUIDE TO PLASTICS—*By Herbert R. Simonds, Published by Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y. Price $6.95. 318 pages.*

This book is a comprehensive summation of properties, costs, forms and sources of all American commercial plastics. It will certainly prove a helpful aid when evaluating the possibility of using plastics for a new product application. General properties such as color, strength, specific gravity, heat resistance, resistance to chemicals are given in tabular form for 32 classifications for plastics. Twenty-three additional tables are so arranged that plastics may be selected to suit a particular physical property required. For the engineer desiring a picture of the over all plastics industry listings are included of trade names, extent of operations and sales figures for leading companies. This volume is a valuable reference work for all levels of engineering and management.

PLASTIC TOOLS AND DIES—*Prepared by Henry E. E. Kortz and Edited by Robert H. Voss, Sr. Published by Mainland Plastic Industries, Inc., 27140 Mound Rd., Warren, Mich. Part I, 94 pages, part II, 72 pages. Price $9.50 each.*

These manuals have been compiled to acquaint personnel having either a lot or no experience in plastics tooling with the essentials of this new industry.

Book I contains information and instructions for making laminate buildup and cast tools such as models, molds, fixtures, templates, dies, etc. Characteristics of basic materials are covered including data sheets. All terms pertinent to the industry are defined. This list also includes "slang" or "shop" words. For broader coverage, a chapter on cold setting pattern rubber is included.

The use of plastics in the manufac-

ture of metal forming dies is not new. However, constant research is producing better and longer lasting dies. In the current stage of development, successful dies have been produced by pressure casting.

Book II of this series covers advanced techniques for pressure cast molds and dies. Methods are explained and illustrated. The book concludes with a chapter on machining of plastics.

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Compiled from the writings of English experts in the field, the first of two volumes deals with hydraulic design principles. It is designed for either the practicing engineer or the engineering student.

Basic hydraulic theory is reviewed, including fluid properties, flow performance. Hydraulic systems and circuits for aircraft are illustrated and discussed. Practical installations in aircraft, as well as the testing of these systems is covered with emphasis on the equipment requirements.

As a supplement to the theory in Volume I, the second book analyses the elements comprising a hydraulic system. This is also a collection of articles by English experts. Seals, pumps, motors, cylinders (jacks, as the English call them) selectors, valves and miscellaneous components are reviewed for the student and the engineer. A chapter on hydraulic servo-controls adapted to aircraft shows specific application data.

Though designed specifically for the aircraft designer, either book would contribute to the understanding of anyone interested in hydraulic systems.

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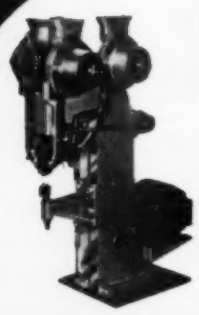

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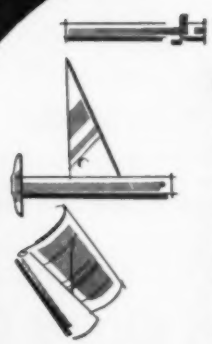

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TOOL ENGINEERING in Europe

By M. Kronenberg
Consulting Engineer
Cincinnati 6, Ohio

Machine Tool Positioning Devices

Automatic positioning of various European machine tools is described by H. Uhrmeister in the same issue of *Werkstatts Technik und Maschinenbau*. The title is: "Einige Moeglichkeiten zur selbst taetigen Lage Einstellung von Werkzeugmaschinen."

The author makes a distinction between three different positioning systems. In the first of these, machining takes place after locating (drilling); in the second, machining takes place when motion is stopped in one direction while a second motion is operative (turning). In the third type of positioning system, machining is accomplished during an accurately synchronized motion along several axes (contour milling). The complexity of the devices increases accordingly.

The author discusses electromagnetic gage systems with selector switches, planetary drives, and preselectors for switching from drilling to milling. Programming systems are also included in addition to photoelectric methods, digital controls, electronic designs and tape controls.

Tool Wear Tests

Averaged results of comparative tool wear tests can be misleading and give erroneous conclusions, according to an article by E. Soom in the Swiss magazine *Industrielle Organisation*, No. 7, 1958. The title is: "Der Verschleiss von Werkzeugen in Abhaengigkeit von Werkzeugfabrikat, Werkzeugdimension und Werkstückmateria" (Tool wear as a function of the brand of the tool material, tool geometry and work material).

A typical case discussed is comparing twist drills of different makes and diameters. What product is the best? At what diameter, under what cutting con-

ditions and work materials? Flank wear is used as the wear criterion. The tests should be run under actual workshop conditions, while a scientific method must be used to evaluate the results. This method is known as variance analysis. Some 192 combinations are possible in the example given in the article. These comprise four different producers, three different work materials, two different diameters and four different classes of holes. By application of statistical checking and evaluation, the author concludes that the effort expended in the tests is less than in the case of the "classical" method of experimentation—where only a single quantity is varied—and that the results are more reliable.

Sintered Carbide Tips

A new classification system proposed by the International Standard Organization (ISO) will divide work materials into three main groups: P = materials producing long chips; M = materials producing long and short chips; K = short chip producing materials. The proposal is outlined by H. U. Rauhaut in *Industrie Anzeiger*, Vol. 80 (60), 1958, p. 914, under the title "Schneidplatten aus Hartmetall—Hartmetall Drehmeissel."

Subdivisions will be made within these groups according to the application of the materials in machining processes and will be shown by two digital figures after the initial letter.

Ultrasonic Vibrators

For ultrasonic drilling, a drilling head has been used in conjunction with a weak solution of boron carbide, according to an article published in *Technisch-Wissenschaftliche Berichte der Osram Company*, Vol. 30 (11/12), p. 344.

Forging Vibrations

Effects of the operation of various types of hammers on workshops and other buildings have been investigated by H. W. Koch, sponsored by the forging committee of the Association of German Mining Engineers. The results and a description of the new methods used in these investigations were published in *Stahl und Eisen*, No. 19, 1958, under the title: "Erschuetterungs-Untersuchungen in der Nachbarschaft von Schmieden."

Intensity of the shock is measured in terms of a unit called a "vibrar," which is equivalent to ten times the logarithm of the ratio of the intensity of vibration to a reference value of 0.1 cm^2 per $sec.^3$ The details of this unit are explained in the report and the unit is related to the amplitude of acceleration (cm/$sec.^2$) and the frequency.

It can be concluded that shock is not transmitted beyond a distance of about 110 ft in the case of swaging hammers and an energy of about 14,500 ft-lb. The limit of shock transmission is at 165 ft for a forging energy up to 88,000 ft-lb. This limit increases to 265 ft in the case of forging hammers and an energy of 88,000 to 160,000 ft-lb. The transmission limits are reduced for counterblow hammers. These data apply to conditions where the shock waves are propagated as in an elastic medium of uniform density.

The author has derived a load-value K as a relation of shock to the effect on working conditions. As an example: a value of $K = 0.1$ does not affect the work and is hardly perceptible, while a value of $K = 3.0$ can be endured for only one hour, affecting working conditions considerably.

Tape Control

A new method for tape control of machine tools has been developed by L. Tschirf and F. Gaertner in Vienna, Austria, according to an article published in *Werkstatts Technik und Maschinenbau*, September 1958, under the title: "Ein neues Verfahren der Tonband Steuerung von Werkzeugmaschinen."

It is claimed that the new method permits much longer machining operations and is also more accurate although the technique has been simplified. The control circuit has been separated from the operation circuit, eliminating the disadvantages of controlling the motions on the basis of error bracketing. Accuracy is therefore independent of the velocity of motion. Practical tests on a lathe have shown that a tolerance of ± 0.0008 inch can be maintained on the diameter.

The electronic controls are so designed that the inertia of the clutches and other machine members do not influence the accuracy of motion. Among the examples given in the article is a case where a workpiece with three different diameters was machined at 355 rpm, a longitudinal feed of 0.004 ipr and a cross feed of 0.001 ipr. An S-2 carbide tool (German standard) with a nose radius of 0.08 inch was used at a cutting speed of 220 fpm on case-hardening steel. The difference between the master part, used for tape recording the dimensions, and ten workpieces was not greater than ± 0.0006 inch.

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technical shorts

New Strength From Experiment In Steel

TENSILE STRENGTHS of more than 400,000 psi have been attained experimentally on an ultra-high strength steel which has been perfected by the metallurgy department of Ford Motor Co.'s Scientific Laboratory. According to Dr. Michael Ference, Jr., director of the laboratory, an illustration of the metal's strength could be implied by a wire of the material one-eighth in. in diameter which could support 4,920 lb.

Dr. Ference pointed out that the strongest metals appear in minute filamentary single crystal wires with diameters only a fraction of a human hair. Metal physicists predict that these iron "whiskers" have maximum theoretical tensile strength of approximately 1,000,000 psi. These properties may now soon be attainable in engineering materials.

The Ford-developed process relies primarily on two factors of temperature and mechanical working prior to tempering. Time is comparatively a minor problem if temperatures of approximately 700 to 1,000 F are maintained during working. Dr. Ference said that the new ultra-high strength steels not only have marked increase in yield strengths, but very good ductility, adding that brittleness normally associated with tensile strengths in excess of 300,000 psi has been overcome.

Basic details of the technique are simple. The steel is mechanically worked while it is in one crystal form (austenite), then changed to a second form (martensite) by quenching and then tempering at about 500 F to obtain higher tensile strengths and ductility.

* * *

Zinc Foil Produced In Sheet Form

A PILOT PLANT unit at American Smelting and Refining Co.'s Central Research Laboratory is turning out developmental quantities of zinc foil in sheets ranging from 0.0005 to 0.001 in. thick, 26 in. wide. In the new method developed by Asarco, zinc is deposited electrolytically from a zinc sulfate bath onto a revolving drum. Foil is stripped from the drum in a continuous sheet of uniform thickness. According to Asarco engineers, the electrolytic process is an economical means of producing foil of high chemical purity with exceptional ductility and tensile strength.

As compared to other metallic foils, zinc foil can be soldered easily and can be printed on.

* * *

Reliability Film Dramatizes Modern Demand

DEMANDS ON product and producer in the new "Age of Reliability" entertainingly depicted in a color, 16-mm industrial film produced by Standard Pressed Steel Co. The 28-minute narrated documentary is presented in layman's English. Humorously dramatized sequences underscore pertinent points. Basic theme of the film, and of the SPS booklet on which it is based, is that today's world is increasingly "an automated, electronically regulated wonderland of technical wizardry."

Copies of the film are available for scheduled group showing through A. W. Scott, Advertising Dept., Standard Pressed Steel Co., Jenkintown, Pa.

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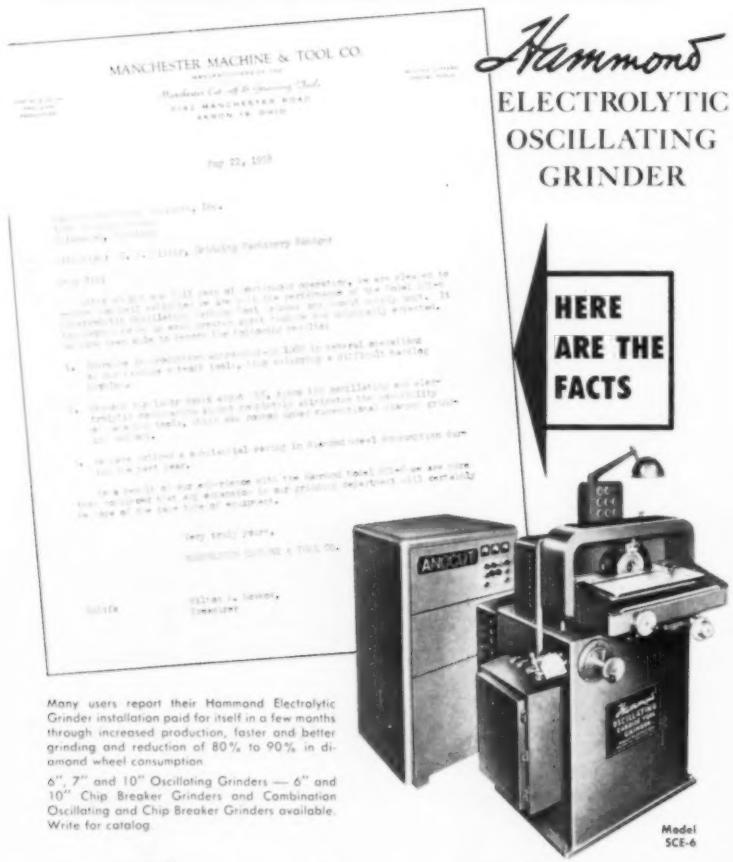

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.....readers' viewpoints

. . . surface plate specifications

To the Editor:

Recently, I attended a specification writing session on surface plates at the invitation of the Canadian government in Ottawa, Ontario. All of the people who attended were skilled in surface plate metrology and had access to the instruments required. Everyone talked glibly about the autocollimator, parallel and mean reference planes, waviness and surface finish.

At home, I stopped to recall the various items discussed. It struck me that what we had done was to write a specification for the few people, like ourselves, who had the instruments and the special knowledge to check a surface plate. But how many shops have an autocollimator, an optical straight edge or even a Rahn planekator? A few very large shops do, but almost none of the small ones. We had been writing a specification for the one out of 1000 surface plate users. But what of the other 999? Must they accept what is given to them? Have they no way of checking a purchase?

I recalled another industry that has a similar problem, the automobile industry. The auto ads and auto salesmen have been stressing engine horsepower, up to 300 hp or more. That's a lot of horses and you are impressed. The salesman perhaps tells you that his car can accelerate from a standing start to 60 miles per hour in 8 seconds. Now you really are sold and you buy one. What is the first thing you do when you get it? Do you drive to a garage and connect the engine to a dynamometer to check the 300 hp? Of course not. You have no dynamometer. But you do take it out on the highway, and make the performance test. If you are able to accelerate to 60 mph in 8 seconds, you are willing to take the manufacturer's word that he put 300 horses under the hood. In any event, the horsepower is merely of academic interest; the only thing that matters is performance.

What is important in surface plates? The only thing that means anything to you is "how accurate are the measurements I take on this plate?" Let the manufacturer develop and produce a surface on which you can take measurements to your desired degree of accuracy. Then, if he cares to, let him write a technical specification that covers such a surface. He can have two specifications: i.e., (1) a technical specification (2) a performance test. You, as a purchaser, can use either or both to check your purchase.

We offer, for consideration and constructive criticism, the following repeat measurement performance test:

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   Inspection grade—50 millionths
   Laboratory grade—25 millionths.

R. J. Rahn
Sales Manager
Rahn Granite Surface Plant Co.
Dayton 7, Ohio

To the Editor:

I agree with Mr. Rahn that current surface plate flatness specifications could be revised so that present instances of misinterpretation would be eliminated. This is not difficult; the British did it years ago. But I do not believe that the viewpoint of any one individual would have much weight.

Rather it has been my feeling for some time that a committee on a national level should be formed under the auspices of ASTE or ASA to resolve this problem. Like its counterparts in other areas, for example, gage blocks, gage blanks, or screw threads, this committee would be composed of representatives from all interested parties—manufacturers, users, military, and the National Bureau of Standards.

I have attempted several times in the past to get the ball rolling but have never been able to find the amount of interest (in the right places) that must exist to get a job of this nature done.

However, perhaps now the time has come to try again. In a recent letter from another prominent surface plate manufacturer, the main theme was the same as that brought out by Mr. Rahn "this confusion in the industry as to what specifications (on surface plates) really mean." With this much evidence of the problem the need to do something certainly exists.

J. C. Moody
Sandia Corp.
Albuquerque, N. M.

Mr. Moody presented his method for logging a surface plate in the February issue of THE TOOL ENGINEER.—ED

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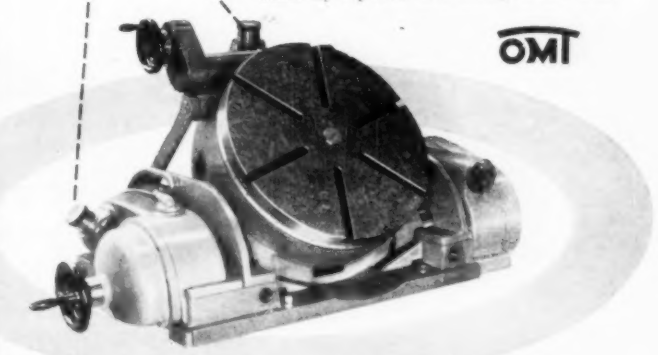

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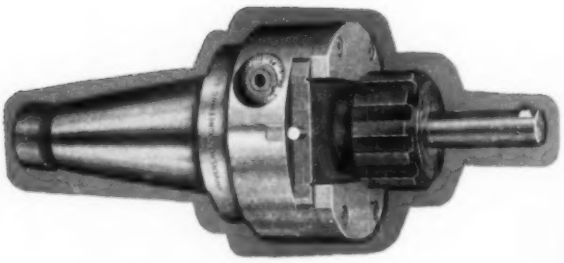

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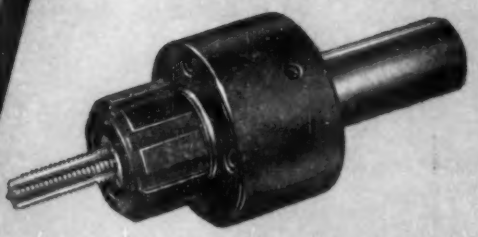

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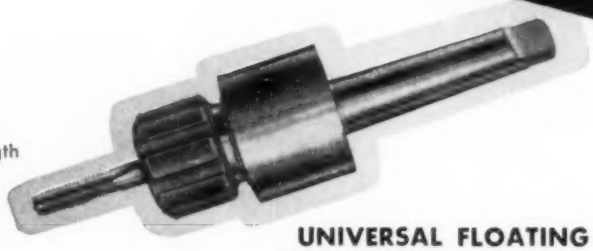

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Trends in Hydraulic Systems

Tech Digests

By P. C. Mortenson

Director of Engineering
Mobile Hydraulics Div.
Vickers, Inc.
Detroit, Mich.

A TREND is a tendency for movement in some direction toward a prescribed goal. If a goal is known, the over-all trend can then be stated. There are presently many specific trends in hydraulic systems because we are in many stages of the over-all development trend. Basic hydraulic system have been used that consist of a fixed displacement pump, a relief valve, a manually operated four-way valve, and an actuating cylinder or motor. However, at the same time, complicated hydraulic systems are used frequently for the control of completely automatic machinery. The latter hydraulic system is much closer to the goal of the "ultimate system" than is the former. But both the simple manual system and the complex automatic system are used and both are a part of the over-all trend.

An example of a present specific trend in hydraulics is the improvement being made in the control of constant feed rates for machine tools. One immediate trend is to improve the existing controls to provide more nearly constant feed rates. Feed control is now generally obtained by the use of pressure compensated flow control valves. Such valves automatically maintain a constant rate of flow regardless of the hydraulic pressure changes within a system, but do not adequately compensate for changes in temperature. However, recent developments now provide for temperature compensation as an integral part of this flow control valve. As a result, machine tool feed rates are now independent of both system pressure and temperature with an accuracy of plus or minus five percent, even though changes in fluid viscosity occur.

In the machine tool industry, a very definite trend exists here—the improvement of flow control valves to compensate for the characteristics of the working fluid that would normally cause the feed rate to vary. However, while this is an immediate trend, there is another trend working to exceed this intermediate goal by the use of a servo valve to maintain a constant feed rate. In this method, the feed rate itself is continually compared with the input signal of the desired feed rate with all the variations compensated for by the servo valve. This type of system can now maintain feed rates within an accuracy of ± 0.2 percent.

The point in making comparison between these two methods is that the first method evidences a trend in the improvement of a component of a system, while the second indicates a trend in complete systems, and is of much greater consequence and significance. The former can be considered an intermediate trend, while the latter one has longer range implications.

Hydraulic systems are generally built up of standard, available components, such as a pump, valves, cylinders, lines, fittings, filters and other accessories. The most prominent of these is the hydraulic pump. Significant trends in pump performance complement similar trends in the mobile equipment industry, as follows:

1. Thirty-five years ago, pump rated speeds seldom exceed 500 rpm, but the advent of the balanced internal combustion engine permitted higher engine rotative speds, and the hydraulic pump followed suit.

2. Twenty years ago, pump speeds of

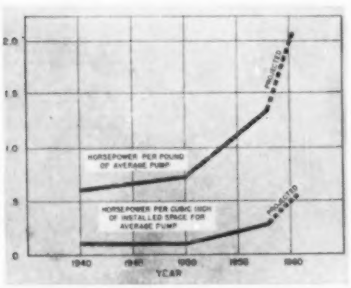

Fig. 1. Trends of increased performance for fixed displacement pumps used on mobile hydraulic systems.

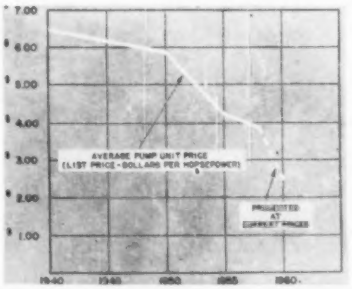

Fig. 2. Cost trend curve for the development of typical mobile equipment pumps over eighteen years.

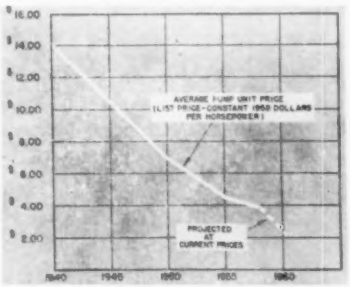

Fig. 3. Graphic representation of the pump prices converted to 1958 dollars. Time period is the same as *Fig.* 2.

1200 rpm were typical of the smaller size units. After World War II, speed again increased surely and steadily until today, speeds of 2000 to 4000 rpm for small pumps are common: 1800 to 3000 rpm for intermediate size pumps and 1500 to 2100 rpm for large pumps are typical. Automotive power steering pumps operating in excess of 10,000 rpm are commonplace.

The increases in rated pump speed have benefited the vehicle designer by reducing weight, required space and cost of pump installations.

Rated pressures at which hydraulic pumps will operate have also been steadily increasing throughout the recent years. Pressure ratings in the mobile field have, with notable success, risen from several hundred psi through 1000 psi, then 1500 psi, and now 2000 psi. A limited number of piston type pumps in the field carry ratings of 5000 psi; however, use in the mobile field is rather limited.

Increase in rated pump speeds ties in closely with increase in rated engine speed. Increase in pump pressures, on the other hand, ties in closely with the increased pressure ratings for valves, cylinders, motors, and other similar accessories. While there are still a few mobile equipment manufacturers operating pumps at 800 to 1000 psi, the majority have increased pressures to the 1500-2000 psi range. The product of increased ratings in speed and pressure has resulted in appreciable increases in pump horsepower ratings, since horsepoweer is proportionate to both of these two factors.

Fig. 1 shows two increasing performance trends for fixed displacement pumps over the past 18 years, and projects this trend for two years ahead. These curves show the gains in specific horsepower ratings. The upper curve shows the increasing horsepower per pound of weight, and the lower curve illustrates the increasing horsepower per cubic inch of package.

Another interesting consideration regarding the cost of this most important hydraulic system component is shown on *Fig.* 2. Records of the selling prices of the group of typical mobile equipment pumps for the past 18 years were divided by the horsepower ratings for those pumps, and this characteristic resulted. Even though the dollar has depreciated considerably during the past 18 years, the cost per horsepower, which is the measure of the pump's true cost, has decreased considerably.

If consideration is given to the depreciation of the dollar by the method recommended by the United States Dept. of Commerce, an even greater appreciation of the specific decrease in pump costs over the same period of years becomes evident. This is graphically shown in *Fig.* 3, which was converted from *Fig.* 2 but interpreted in terms of the 1958 dollar. On a dollar basis, it is possible to buy three and one-half times more pump today than was possible in 1940.

In order to economically provide optimum hydraulic systems, design of separate hydraulic components in wide ranges of capacities and capabilities is underway. While this has been a trend in the past, it is now being approached on a more organized and on a more extended basis. As an example of this trend, let's look at the capacities of fixed displacement pumps.

Manufacturers of engines, transmissions, clutches and similar mechanical equipment have made substantial strides in the reliability and service life. Materials handling equipment, earth-moving vehicles, on the highway and off the highway equipment, agricultural machines and other related mobile equipment have become increasingly reliable, and the time between minor and major servicing has, in the past several decades, increased tremendously. The hydraulic equipment manufacturer has kept pace with these other related industries. A decade ago, pump life of 500 hours was considered typical, whereas today, pump life of 2000 hours can well be expected. There are numerous examples in the earth-moving industry where, under proper conditions of cleanliness in the hydraulic system, pump life of 3000 hours and better can be obtained.

Another significant component in a hydraulic system is the control valve. Trends in valve design follow pump design very closely. Savings in space, weight, and cost are equally applicable. The trend toward higher pump operating pressures could not exist if not for a similar trend in the areas of valve design and manufacture. Hydraulic system pressures are definitely on the rise. The valve component of those systems will keep pace.

Fig. 4 presents the trend in pump capacities plus the addition of a hypothetical series of directional control valves to complement the pumps. Such a family of valves could be designed around the SAE standard four-bolt fittings by establishing capacities that are based upon the constant fluid velocity through those fittings. This series would have to incorporate such features as individual check valves, low override relief valves, pilot or solenoid actuation, low pressure drops, minimum over-all dimensions, and would

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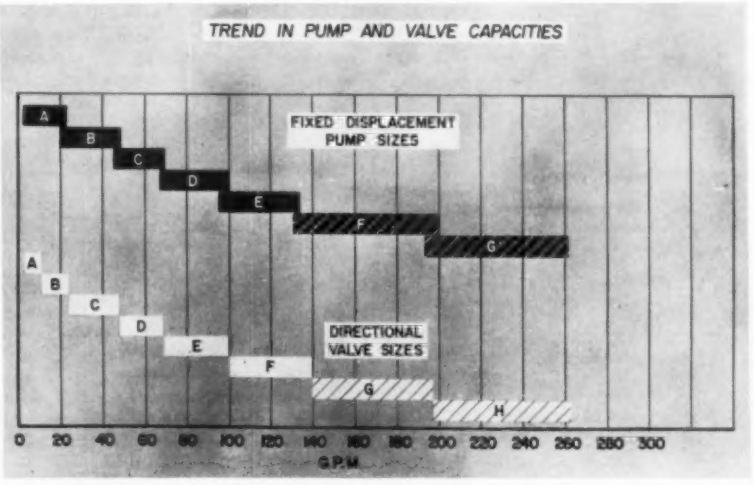

Fig. 4. Trends in fixed displacement pumps capacities have been plotted against the flow characteristics. Superimposed on the chart are a hypothetical series of directional control valves which could complement the pumps.

have to provide for series flow, parallel flow or any reasonable combination thereof. Although this trend has not been clearly established, it is only a matter of a short time before valves of these capacities and the pumps referred to previously become available on an industry-wide basis.

There is a definite need in the hydraulic industry for the development of flexible hoses and fittings that carry ratings of 2500 psi or better, and are capable of handling volumes up to 300 gpm at that pressure. Present fittings and hoses in the larger sizes are a long way from meeting this need. The trend toward increased volumes of fluid flow has existed for a substantial period of years, but the rate of increase in both pressure and fluid flow quantity in now increasing exponentially.

Great needs exist today in the field of hydraulic fluid filtration. High performance hydraulic systems contain pumps and valves that have clearances in the order of 0.0002 inches. If surfaces separated by such minute clearances are to operate smoothly, a clean film of oil must be maintained between them. As long as this film of oil is intact, the two surfaces can move relative to each other almost indifinitely. Any hydraulic system has a number of such similar surfaces, and these will function properly only if the fluid is free of contaminating particles. Either the oil film or the contaminating particle can occupy this space, but not both. There is no escape—the system must be kept clean.

Based on a paper presented at the SAE National Farm, Construction, and Industrial Machinery Meeting of the Society of Automotive Engineers, Inc., 485 Lexington Ave., New York 17, N. Y.

▼ ▼ ▼

Vibration Damping Capacity of Magnesium Alloys

By D. F. Walsh, Metallurgist
J. W. Jensen, Physicist
J. A. Rowland, Metallurgist
Bureau of Mines
U. S. Dept. of the Interior
Rolla, Mo.

Damping capacity studies were made on a number of magnesium-base alloys, commercial types and experimental compositions. Hardness and tensile properties were determined and the microstructure of each alloy was examined. In general, alloys of low yield strength showed high damping ability.

The cast alloys had with two exceptions, extremely high damping capacity. It is significant that these two exceptions were the only compositions of high alloy content. Of all the alloys studied, those that had a relatively high alloy content were low in damping capacity, and those of low alloy content had high damping capacity.

Addition elements occurring as a separate phase or in solid solution reduce the damping capacity of magnesium-base alloys. The extent of this effect varies with the particular element added and correlates with the strengthening effect of the addition.

Damping capacity of magnesium alloys is in general closely related to stress. In many cases, magnesium alloys exhibit extremely high damping capacity at relatively low stress levels; there are a few compositions, however, that exhibit very low damping capacity over a wide range of stresses. If the only necessary criterion is vibration damping ability, magnesium alloys can be selected to provide any reasonable degree of damping capacity at an appropriate stress level.

From a paper presented at the 14th Annual Convention of The Magnesium Association, 122 E. 42nd St., New York 17, N. Y.

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Automation Ins and Outs

By Bernard J. Wallis
President
Livernois Engineering Co.
Dearborn, Mich.

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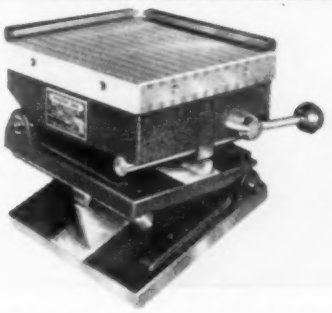

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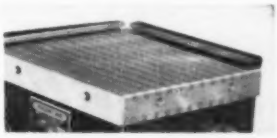

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productivity is the most significant single key to provide these jobs. Automation is a tool through which productivity can be increased; and to quote from H. W. Prentis, Jr., Chairman of the Board of Armstrong Cork, "Like many other men in industry, I believe that increased productivity cannot be achieved to any great extent without adoption of partial or complete automation."

At this point, someone might wonder what is this cure-all automation? First of all, it is not a cure-all, but a tool for alert management. At Ford Motor Co., the term was used by D. S. Harder to describe a system for the automatic handling of parts between manufacturing operations. Popular use of the term in the newspapers has broadened its meaning until it now includes all phases of mechanization up to and including the complete push-button factory.

There are as many definitions as there are authors in this field. I have a personal definition that I believe includes these many variations. It is simply that automation is the integrated, continuous processing extending from the time the part to be processed enters the equipment until it emerges, with the equipment operations being internally controlled and automatically readjusted.

The question may be asked what plants should automate? A survey conducted by the American Society of Tool Engineers in 1957, indicates the maximum potential for automating plants of all sizes is about 16 percent. In plants with 250 to 1000 employees, this figure varied from 28 percent in the machining industries down to 10 percent in the production welding industries. These figures, in the face of advancing technology, have a habit of changing. With due respect to the American Society of Tool Engineers, because I think they are contributing a great deal to the field of manufacturing, these figures were correct information at the time they were gathered, but changing times and changing paces will affect their relative standings. It is my opinion that changes in the design of products, the introduction of new materials, new methods of processing, and an expression of mechanical ingenuity will bring this figure closer to 50 percent for all industry. Fifty years ago, it was said that men would never fly, but today we are on our way to the moon. This same type of progress will lead to 50 percent automation and, ultimately, the push-button factory.

This same A.S.T.E. report shows that the medium sized plant can automate to a greater extent than a large plant. The example cited was the manufacture of a complete automobile, compared to the machining of an engine block. At our present state of the manufacturing science, this is a true comparison. However, if the automobile were designed for automation, and I am sure it ultimately will be, the automation of the larger plant will be just as extensive as the medium-sized plant. Currently, our attempts to automate body assembly are obstructed by welding techniques and material handling. These difficulties will be overcome by advancements in welding technology and body panel redesign.

Now, what have I been trying to say with these examples? The fact is that anyone can automate—from the smallest to the largest of shops. Such a generalization would shock many people, but what must be remembered is that

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automation must be approached with the callous eye of the accountant, the creativeness of the engineer, the ingenuity of the job-shop owner and the openmindedness of the visionary.

These important factors are not the province of the titans of industry, they can be exercised by anyone. Small shops can apply ingenuity that exceeds what the large shop has to offer. By way of example, I know of a case where a large established machine tool manufacturer refused to quote on a piece of equipment that they thought impossible, let alone economically feasible. A newcomer to the field designed and built the equipment for half what the purchaser would save in a year.

Now, we have an idea of what to automate and when to do it. We've discussed briefly the detailed requirements of automated equipment. But what about the overall equipment, how do we recognize a good machine from a poor one? How do we know we're getting our money's worth? We have all had experience with getting several quotes on a given piece of equipment—each one guaranteeing to do the required job —yet each vendor has different specifications for doing the job. So, then, what must we look for? Well, it isn't the lowest price very often And, it isn't necessarily the most experienced manufacturer! The primary criteria of the acceptability of a piece of automation are durability, versatility and ease of maintenance.

Based on a paper presented at the Thirteenth Annual Technical Convention of the American Society of Body Engineers, Inc., 100 Farnsworth Ave., Detroit 2, Mich.

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Stress Effects of Abrasive Tumbling

By H. R. Letner

Manager
Incandescent Lamp Advance Engineering #436
General Electric Co.
Nela Park
Cleveland, Ohio

Tool steel specimens at four hardness levels were tumbled with aluminous abrasives under a variety of conditions, and the resulting surface stresses were measured. Behavior was observed for three initial stress conditions: stress-free surfaces, ground surfaces, and heat-treated surfaces. Residual stresses induced in initially stress-free steel by tumbling were always compressive at the surface and decreased uniformly to zero at a depth of a few thousandths of an inch. The magnitude and depth of penetration of the stress increased with particle size, but depended very little upon the type of abrasive used. Steel hardness affected both the magnitude and depth of penetration; the maximum compressive stress at the surface increased, and the thickness of the stressed layer decreased, with increasing hardness. Tumbling removed initial surface stresses in layers up to a few thousandths of an inch thick, and replaced them with its own characteristic compressive stress. The degree to which this substitution took place also depended upon the size of the abrasive and the hardness of the steel.

From a paper presented at the Fortieth Annual Convention of the American Society for Metals, 7301 Euclid Ave., Cleveland 3, Ohio.

▼ ▼ ▼

Plating Finishes for Magnesium

By Joshua P. Levy
American Electroplating Co.
Cambridge, Mass.

Electroplating on magnesium generally parallels the techniques and problems associated with plating on aluminum. These are: cleaning, activating, zinc immersion coating, copper plating, additional plating. As with aluminum, different alloys of magnesium require the use of specific cleaning methods to insure surfaces that are suitable for activating, zincating and plating.

Magnesium parts, whether extruded, die cast or wrought, have a thin skin which, in composition, is distantly related to the parent metal. Oxides, graphitic and other inclusions, some alloying with the dies, local variations in composition, porosity, these are some of the gross contiminants the incomplete removal of which seriously affects the zinc immersion coat and electroplate.

Comparing the plating on magnesium to plating on aluminum, it is found that: 1. The equipment and installation costs are roughly comparable. 2. More stringent solution and process control is necessary for plating on magnesium than on aluminum. 3. For decorative requirements not involving ambient elevated temperatures, the plating cost is comparable. 4. For high temperature use, the additional oven bake introduces an added cost with magnesium. 5. The cost of stripping and reworking is higher than for aluminum. 6. Knowledge of alloy and history is more important than with aluminum.

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ver, gold, rhodium, cadmium and zinc, can be deposited, however, an undercoat of copper is usually required for optimum adherence. Zinc, cadmium, brass and silver can be deposited directly.

With present methods, the electroplates or deposits produced on magnesium are equal in quality and performance to the same electroplates deposited on other metals. In those applications where the physical properties of magnesium make it desirable, the electroplating problems are no deterrent to its use.

From a paper presented at the 14th Annual Convention of The Magnesium Association, 122 E. 42nd St., New York 17, N. Y.

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Recent Developments in Pipe and Tube Mill Machinery

By Dieter Hancke
VP—Sales
and
Robert Hartenstein
VP—Engineering
Mannesmann-Meer Inc.
Youngstown, Ohio

Recent design developments in the field of equipment for seamless tube mills include a new small-diameter high-torque-capacity piercing mill roll spindle coupling with provision for fast disconnect and exchange of universal joint slippers. A radically new single-groove roll plug mill with entirely open and easily accesible inlet side and with a unique direct roll drive by individual d-c motors with acceleration during the rolling time; a new type of individual reeler roll drive by slipperless universal joint spindles; two new sizing mills of unconventional design with fast schedule change feature and a three-roll type, 12-stand reducing mill for rerolling of seamless tubing stock under highly flexible schedule pattern conditions, also, have been developed.

A redically new type of stretch reducing mill with a hydromechanical variable speed drive adds program flexibility and extremely short schedule change-over time to the inherently high tonnage capacity of electric resistance pipe welding mills for the production of hot finished pipe at constant output through full size range. High accuracy of cut and simple design characterize a newly developed flying hot saw installed behind a stretch reducing mill to separate strand of pipe rolled from 190-ft shells. A fully automatic elongation measuring device permits accurate reading and control of wall thickness of pipe while being rolled in stretch reducing mills.

New designs have been introduced to the field of cold working of tubing and pipe. A unique seven-roll straightener permits triple deflection one-pass straightening of plain end pipe and oil well tubing with externally upset ends, and features ease of setup and fast roll changes. Cold outside diameter reduction for resizing after heat treatment and for increase in physical properties of carbon steel pipe is performed on new type three-roll cold mills with close stand pacing at high speeds. High-speed multiple drawing of steel and nonferrous tubing is the result of the introduction of a new wire rope drive for draw and carriage return cycles on cold draw benches. The development of a mechanically compensated drive for cold pilger mills has practically doubled production capacities of this equipment for cold rolling of stainless and carbon steel, as well as nonferrous tubing.

Based on a paper presented at the Annual Convention in Cleveland, Ohio, of the Association of Iron & Steel Engineers, 1010 Empire Bldg., Pittsburgh 22, Pa.

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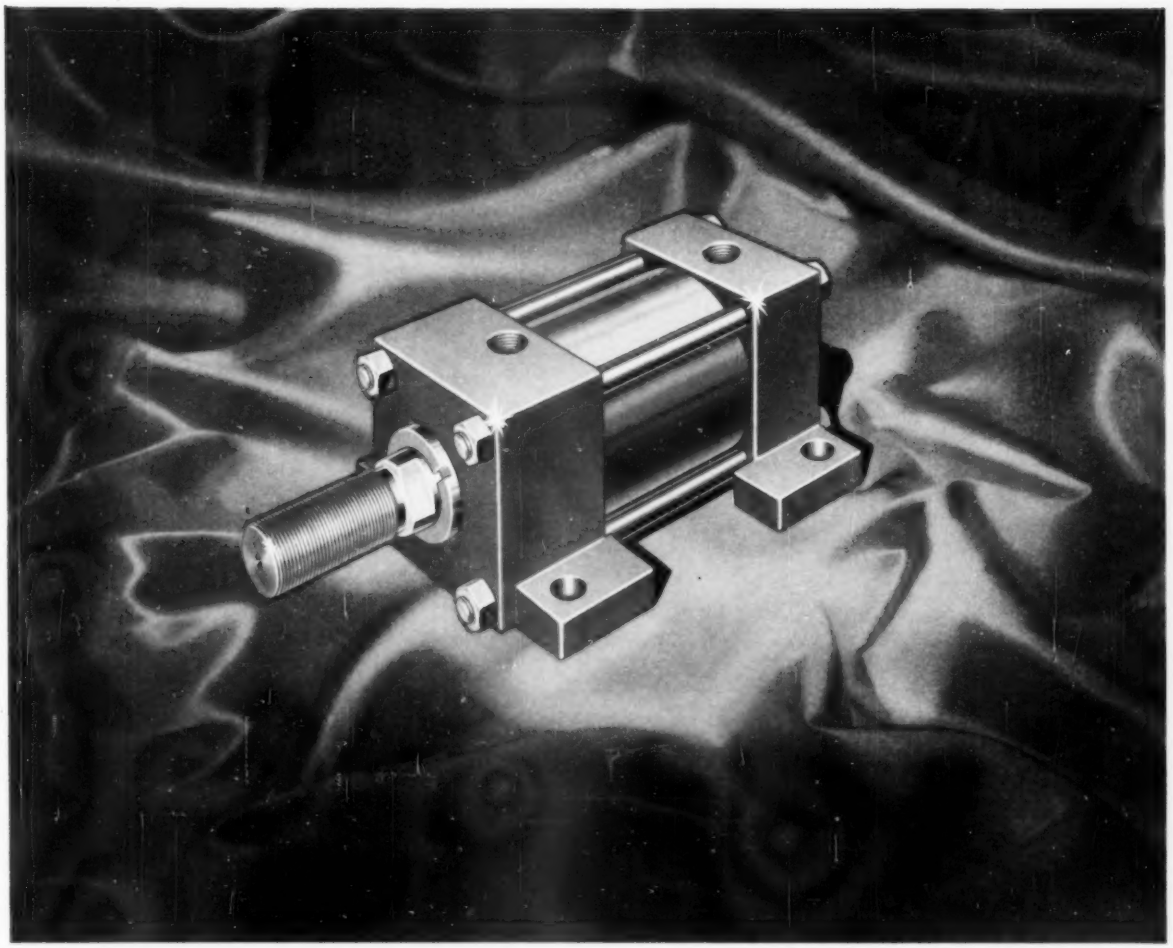
Comparison of Methods of Determining Stress Concentration Factor

By J. D. Lubahn
General Electric Co.
Schenectady, N. Y.

Stress concentration factors determined analytically and photoelastically have been compared with new measurements by wire-resistance strain gages for a V-notch Charpy impact specimen. The value obtained by strain measurement agrees with the analytical value and is about 12 percent lower than the value obtained photoelastically.

Similar comparisons for other geometries reveal camparable differences (in the neighborhood of 10 percent) between strain gage measurements and values of stress concentration factor obtained otherwise. For the V-notch Charpy impact specimen comparison of photoelastic stress concentration factor with values obtained otherwise shows a larger difference than in other comparisons for cases of plane stress or cylindrical symmetry.

Based on a paper presented at the Annual Meeting of the Society for Experimental Stress Analysis, Central Square Sta., P. O. Box 168, Cambridge 39, Mass.



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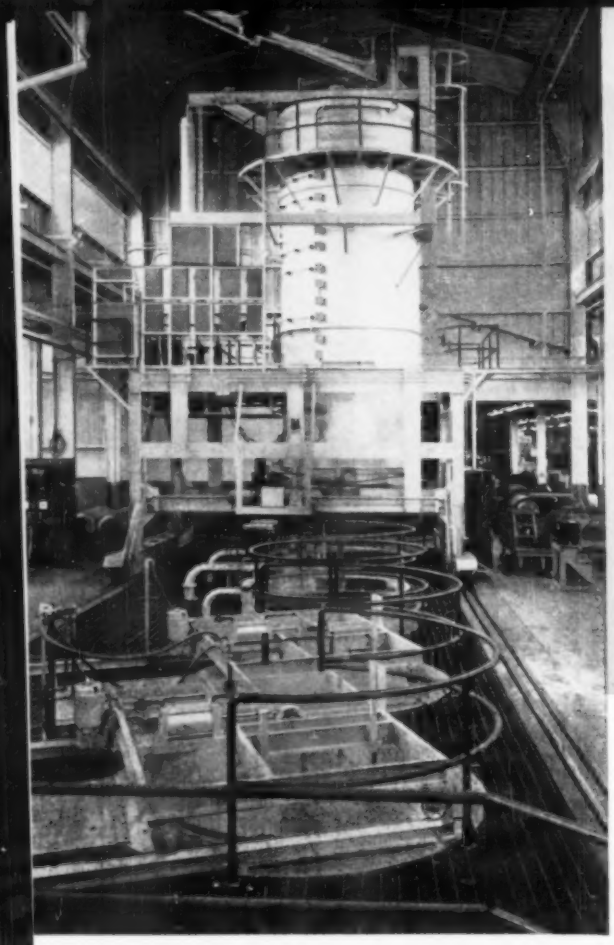

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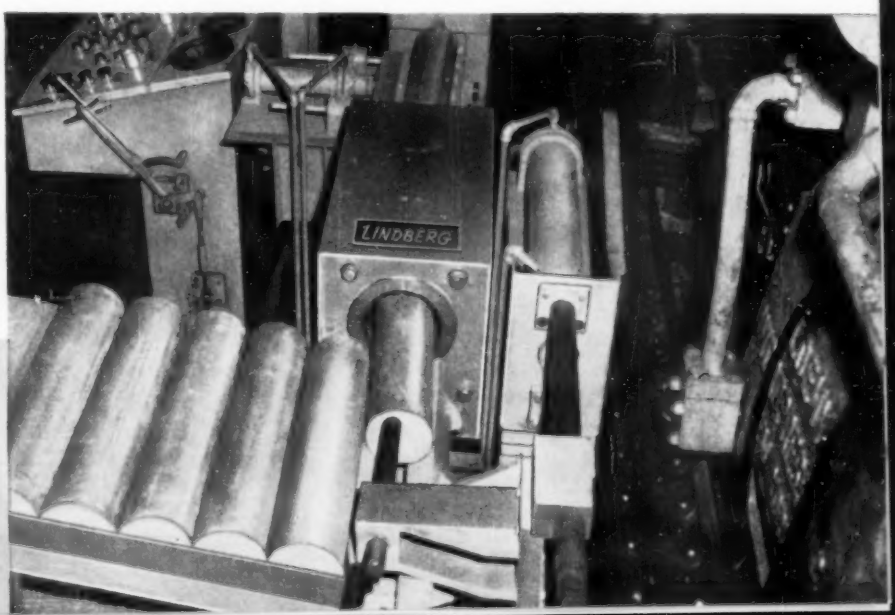
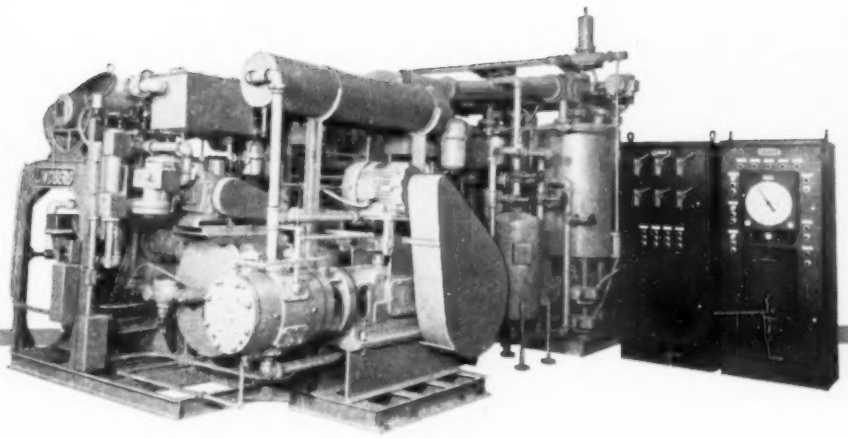
Not so many months back business wasn't booming in the metalworking field. But through this period, Lindberg went steadily ahead with its policy of helping make business better by constantly seeking better ways to apply heat to industry. Fortunately, Lindberg has the research experts, the designers, the engineers to implement this policy. As evidence, shown on these pages are five major Lindberg developments of the past twelve months. In their respective spheres these offer industry more efficient, more productive, more economical industrial heating equipment.

Induction Aluminum Billet Heater. This exclusive new Lindberg induction billet heater provides aluminum extruders with an accurate, efficient solution to a difficult production problem. It features "Metered BTU's", an improved control system for heating aluminum billets. The heating rate of billet is controlled and each billet automatically delivered to the die-casting machine at the exact temperature required for most efficient extrusion.



Full information on any of these new Lindberg developments is available from Lindberg Engineering Company, 2447 W. Hubbard St., Chicago 12, Ill.



Hyni Nitrogen Generator. This Lindberg Hyni nitrogen atmosphere generator is the latest development in gas processing and assures nitrogen of higher purity than has ever before been achieved by other processes. It is the first unit to provide low cost, high purity nitrogen by a dry, completely automatic process. It is suitable for any application where a high nitrogen, CO_2 free, dry atmosphere is required. The unit functions automatically, and once the generator is started, the entire operation is completely automatic and continuous.

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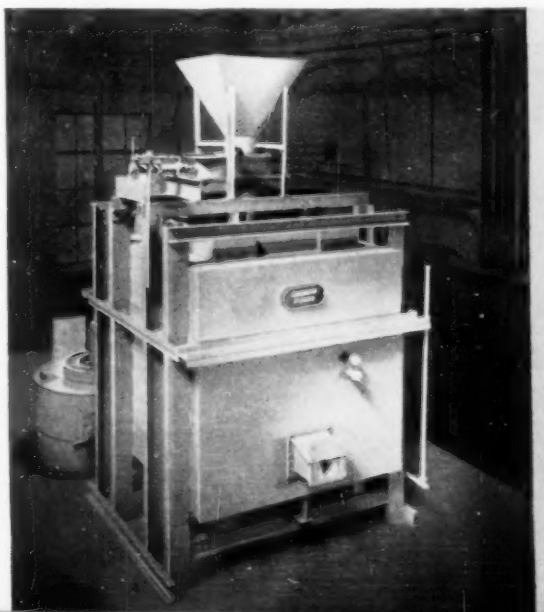
Electric Controlled Atmosphere Dry Hearth Melting Furnace. This new Lindberg-Fisher Melting Furnace operates electrically and oxidation of aluminum, or melt loss, is reduced because the entire system can be pressurized with atmosphere. The only oxides incurred are those from the surface of the scrap, as charged. The furnace contains a sloping silicon carbide dry hearth which directs the molten aluminum through a covered trough into the companion holding furnace. Substantial savings in lower melt loss and maintenance is low. Particularly applicable for scrap with steel inserts.



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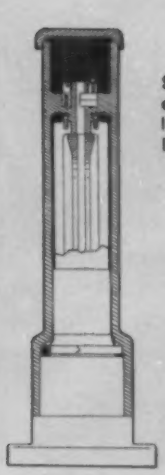

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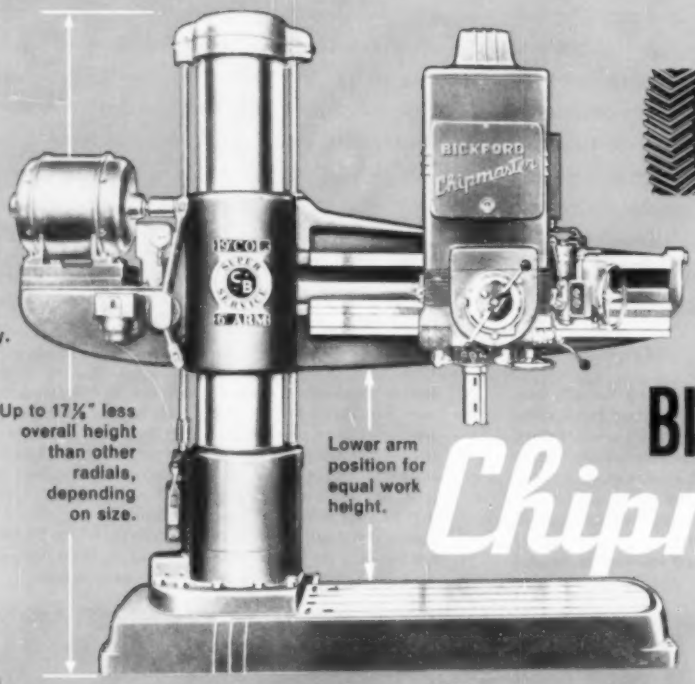

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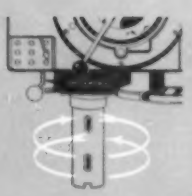
Preloaded spindle bearings—four preloaded precision ball bearings take severe thrust and radial loads of heavy boring and drilling. Spindle is heat-treated chrome-nickel alloy steel.

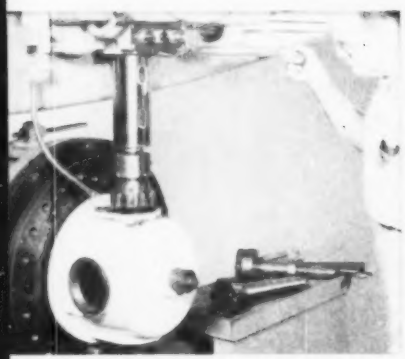
Spindle sleeve is carried in honed bore—17⅛" of support for the precision-ground, chrome-plated, heat-treated alloy steel sleeve!



Instant reversal of spindle at any speed—heavy herringbone drive gear is declutched for high-speed operation. Absence of flywheel effect permits instant reversal of spindle at any speed.

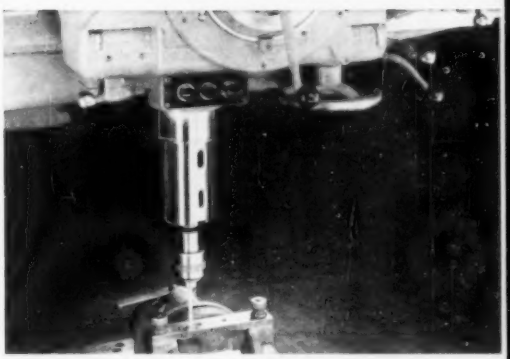
that proves the difference . . .

that cuts costs on jobs like these!



TAPPING CLASS 3 FIT THREADS! Hole is bored to size at .083-inch feed in 27 seconds, faced at .020-inch feed in 25 seconds, and tapped to a class three fit in 40 seconds, a total of 1⅓ minutes for all three operations!

BORING "BANJO" HOUSINGS! Here's a job that proves a radial! 19¼-inch boring of cast steel differential housings on production-line basis. Cincinnati Bickford radials also are used for drilling, tapping, and facing operations on this part.



SMALL HOLE DRILLING AND TAPPING! The same Chipmaster that will handle heavier jobs than any other radial is an accurate, sensitive machine to handle 3/16 and ¼-inch drills and taps at high speeds without breakage.

The all-new Cincinnati Bickford Chipmaster radial drilling machine enables you to handle jobs on radials that you are now handling on more costly machines.

Look at the pictures above. Here's a machine that runs the range from the heaviest boring, drilling, spade drilling, trepanning, and facing operations to light-duty high-speed drilling and tapping.

When you have a machine that will make the *Big Chip* shown at the top of this page, you know you have rigidity, thrust capacity, power, accuracy, and versatility never before equaled in a radial drill.

. . . The speed and feed you need for the job you want to do:
drilling—boring—tapping—reaming—spade drilling—trepanning—facing

36 speeds in any of 5 ranges:
8-1000, 10-1250, 12-1500, 14-1750, or 18-2300 rpm.

18 feeds: .004" to .125"

Tap leads—3 ranges:
8, 11½, 14, 18, 20, and 27, or
8, 10, 12, 14, and 27, or
8, 10, 11½, 14, 20 and 27

To save time and cut costs, to do more than ever before with a radial, get all the facts about the Bickford Chipmaster. Call your Bickford distributor or WRITE FOR CATALOG TODAY.

CINCINNATI BICKFORD DIVISION
Giddings & Lewis Machine Tool Company
Oakley, Cincinnati 9, Ohio

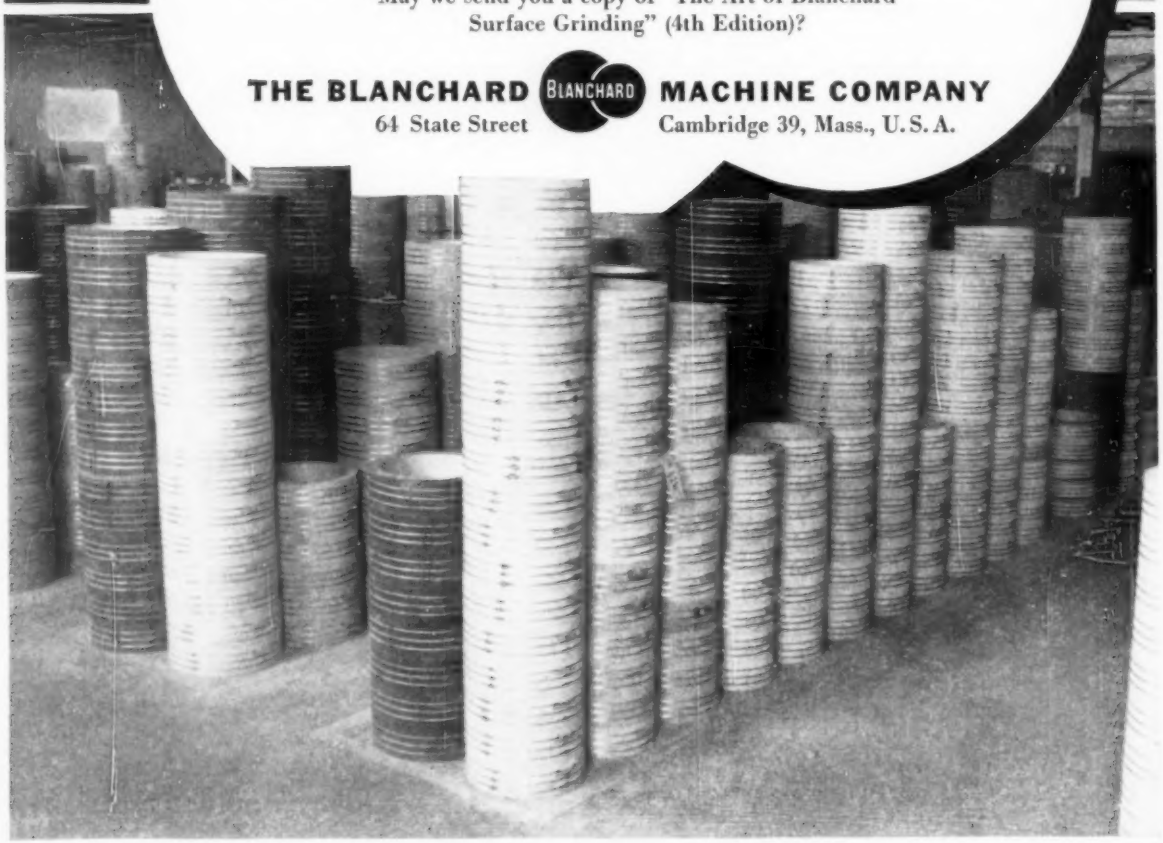
GIDDINGS & LEWIS

When you "Put it on the Blanchard"
. . . be sure to use Blanchard Wheels

Your Blanchard Surface Grinder is designed to give you peak production and economy on hundreds of different grinding jobs. But, for every job you run, *there's one particular wheel that does it best!* That's why Blanchard manufactures and stocks a wide variety of silicate, resinoid and vitrified bonded wheels and segments.

Your Blanchard representative will be glad to help you select the wheel—or wheels—best suited to *your* grinding operations. Call or write him today. May we send you a copy of "The Art of Blanchard Surface Grinding" (4th Edition)?

THE BLANCHARD MACHINE COMPANY
64 State Street — Cambridge 39, Mass., U.S.A.



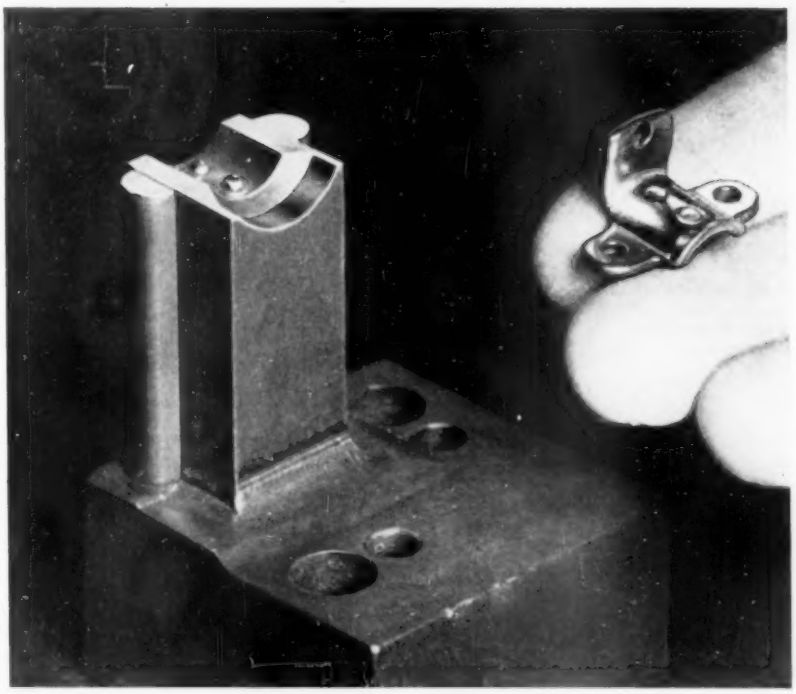
Tool Steel Topics

BETHLEHEM STEEL

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Distributors: Bethlehem Steel Export Corporation



1½ million pieces with Lehigh H ...that's a long run in any league!

At Harvey Hubbell, Inc., Bridgeport, Conn., they were using a competitive grade of tool steel to form cord-clamp sections made from Grade 1010 steel strip. But each time they hit an average figure of 700,000 pieces, the die cracked, and had to be replaced. The manufacturer decided to call in Lindquist Steels Inc., a local distributor of Bethlehem tool steel.

"With the finished part only .060 in. thick, we ought to do better than 700,000 pieces. What do you suggest?"

The distributor studied the operation, the cracked die, and the finished part. "I'd recommend Lehigh H," he said. "It has the strength you need in a forming operation of this sort." The Lehigh H was put on the job and produced 1½ million pieces without any trouble.

Lehigh H is our high-carbon, high-chromium, air-hardening tool steel. It's a grade with outstanding wear-resistance and toughness. And it's also a deep-hardening steel with high compressive strength.

The best way to evaluate Lehigh H is by putting it to work—not in an easy job, but in a tough one. Your Bethlehem tool steel distributor carries Lehigh H in stock, and will see that it's delivered promptly. Get in touch with him.

TYPICAL ANALYSIS

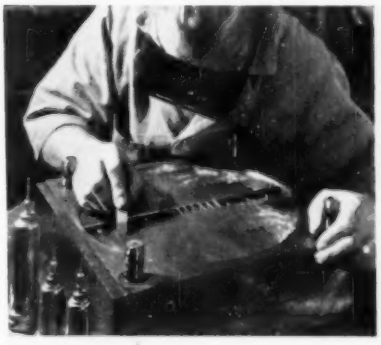
Carbon 1.55
Chromium 11.50
Molybdenum 0.80
Vanadium 0.90

BETHLEHEM TOOL STEEL ENGINEER SAYS:

Don't Use Fresh Water For Quenching Tools

Fresh water, regardless of its source, contains dissolved gases which make it unsuitable for quenching tools. When tools are quenched in fresh water, gas is liberated at the surface of the tool. Gas pockets thus formed may prevent contact between tool and water, resulting in soft spots from ineffective quenching. Soft spots are undesirable because of their low hardness, and also because a quench which produces them may also cause cracking of the tools.

Soft spots, and tool cracking associated with soft spots, can be avoided by quenching in water which has been previously boiled, to remove the dissolved gases. If water cannot be boiled, quench a large amount of hot "dummy" material to expel the gases. As a further precaution against soft spots, it is preferable to use a 10 pct brine solution instead of water. It is also suggested that the dissolved gases be expelled from the brine solution before use.



USE DURAMOLD FOR COLD-HOBBING

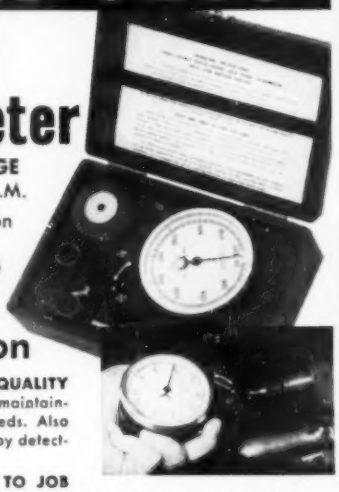
Bethlehem's Duramold tool steels, in Grades A and B, are ideal for cold-hobbing plastic dies because they are free from injurious surface and internal defects. Duramold A, an air-hardening grade, is annealed to 109 max Brinell. Duramold B hardens in oil, and hobs more readily than Duramold A. It is annealed to 100 max Brinell, and has an addition of boron to increase the core strength.

JONES #3200

Hand Tachometer

BROAD RANGE
50 — 5,000 R.P.M.
with stop button

assures better production



HIGHER OUTPUT — QUALITY CONTROL obtained by maintaining proper machine speeds. Also helps avoid breakdowns by detecting irregularities.

CARRY IT FROM JOB TO JOB and keep it handy for quick, accurate tests. Choice of readings in R.P.M., F.P.M., etc.

GUARANTEED ACCURACY—superior construction, trouble-free. Unaffected by moisture, temperatures, electric currents.

Many other Portable and Stationary Models, indicating Speeds between 50 R.P.M. and 50,000 R.P.M., are available.

Write for catalog 146 -

JONES MOTROLA CORP.
Stamford, Conn.

USE READER SERVICE CARD; INDICATE A-12-166-1

NEW CARL ZEISS JENA OPTICAL DIVIDING HEAD

PERMITS PRESETTING TO ANY DESIRED MINUTE AND SECOND FACTOR FOR NEXT OPERATION WHILE FIRST OPERATION IS IN PROGRESS

does not depend for accuracy on worm, worm gears or index plates. It is a thoroughly practical, rigidly constructed tool.

INDEXING BY A DIVIDED GLASS CIRCLE AND VERNIER, FULLY PROTECTED AND ENCASED, MOUNTED DIRECTLY ON SPINDLE, THUS NO INACCURACY FROM GEARING, WEAR OR PLAY.

BUILT FOR PRODUCTION USE on MILLER and GRINDER

Accuracy ±5 Seconds
Range of Scale: 0 to 360 Degrees

WE GUARANTEE EXPERT SERVICE ON ALL CARL ZEISS-JENA INSTRUMENTS AT ALL TIMES

Get the FULL STORY of this OUTSTANDING SHOP and INSPECTION AID REQUEST CIRCULAR

GEORGE SCHERR CO., Inc.
COMPLETE LINE OF PRECISION INSTRUMENTS
WEST COAST BRANCH: SCHERR-TUMICO CO. - 3337 W. Olympic Blvd. - Los Angeles 19, Cal.
200-TE LAFAYETTE STREET • NEW YORK 12, N. Y.

USE READER SERVICE CARD; INDICATE A-12-166-3

SHELDON CHICAGO U.S.A. *Sebastian*

New 13" and 15" Precision Geared Head Lathes

These new, more powerful, more capable lathes will: Work to the closest tool room tolerances ... Stand up under continuous, heavy-duty, production runs ... Available in 5', 6' and 8' bed lengths ... Features hardened bed ways, dial selector for spindle speeds; automatic lubrication of headstock and apron; independent drop lever clutches for power feeds; heavy, modern pedestal and 60 pitch gear box.

Write for catalogs describing the new cost-cutting machine tools designed and built by SHELDON, and, the name of your nearest distributor where you can see and test them in operation.

SHELDON MACHINE CO., Inc.
4229 N. Knox Avenue, Chicago 41, Illinois

USE READER SERVICE CARD; INDICATE A-12-166-2

"MONOBALL"® Self-Aligning Bearings

CHARACTERISTICS

	ANALYSIS	RECOMMENDED USE
1	Stainless Steel Ball and Race	For types operating under high temperature (800-1200 degrees F.).
2	Chrome Moly Steel Ball and Race	For types operating under high radial ultimate loads (3000-893,000 lbs.).
3	Bronze Race and Chrome Moly Steel Ball	For types operating under normal loads with minimum friction requirements.

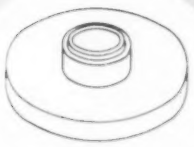
Thousands in use. Backed by years of service life. Wide variety of Plain Types in bore sizes 3/16" to 6" Dia. Rod end types in similar size range with externally or internally threaded shanks. Our Engineers welcome an opportunity of studying individual requirements and prescribing a type or types which will serve under your demanding conditions. Southwest can design special types to fit individual specifications. As a result of thorough study of different operating conditions, various steel alloys have been used to meet specific needs. Write for revised Engineering Manual describing complete line. **Dept. TE-58**

SOUTHWEST PRODUCTS CO.
1705 SO. MOUNTAIN AVE., MONROVIA, CALIFORNIA

USE READER SERVICE CARD; INDICATE A-12-166-4

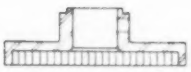
Bodine

CASE HISTORY NO. 48...



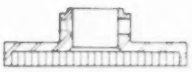
Hand load blank to fixture-type dial. Auto inspect and clamp.

1



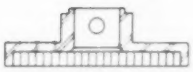
Drill .173" dia. one side. Horizontal drill spindle.

2



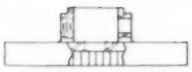
Drill .116" dia. 2nd side and chamfer. Combination tool. Horizontal drill spindle.

3



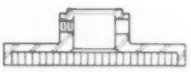
Drill .187" dia. hole through. Vertical drill spindle.

4



Tap #6-40 CL 3 hole to size. Horizontal tap spindle. ALSO drill .187" dia. hole. Vertical drill spindle.

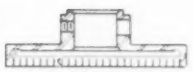
5



Countersink .430" dia. with Welden 90° c/sink. Vertical drill spindle.

Auto inspect for broken drills or taps.

6

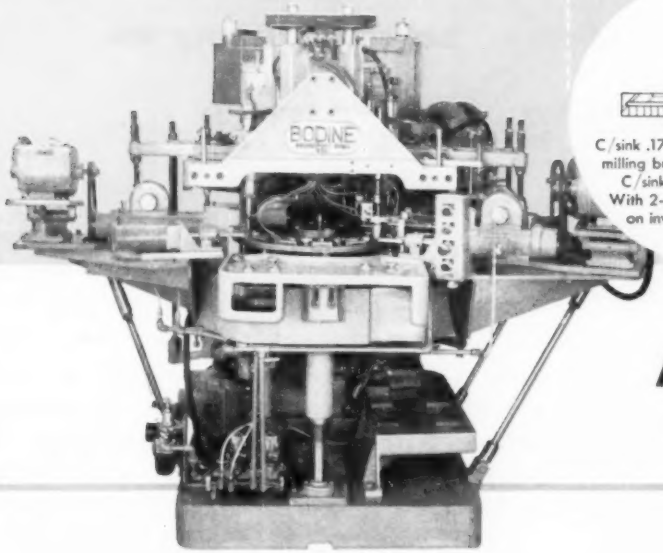


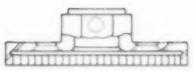
Undercut teeth using special recessing tool. Inverted drill spindle. (Hold down vertically.)

7

Gang mill .062" slot and flat. Vertical milling spindle.

8





C/sink .173" dia. hole to remove milling burr. Horiz. drill spindle. C/sink 2 .187" dia. holes. With 2-spindle multiple-head on inverted drill spindle.

9

Ream .430" dia. to remove burr. Vertical drill spindle.

10

All this and better QUALITY CONTROL too!

PART and MATERIAL: Clutch drum, steel B1117

PRODUCTION: 4200 operations (300 pieces completed) per 50 min. hour.

The remarkable versatility of Bodine Basic Machines and tooling methods is well illustrated by this recently completed unit for Teletype Corporation. Production, however, is only part of the story. Superior *quality control* was the main reason for development of this new production method for Teletype.

The part is a steel clutch drum on which no less than *14 operations* are performed, with two automatic inspections built into the cycle.

There are 4 vertical drill spindles and 1 vertical milling spindle; 3 horizontal drill spindles and 1 horizontal tap spindle; 2 inverted drill spindles. Parts are hand-loaded but automatically ejected. The station is washed after ejection.

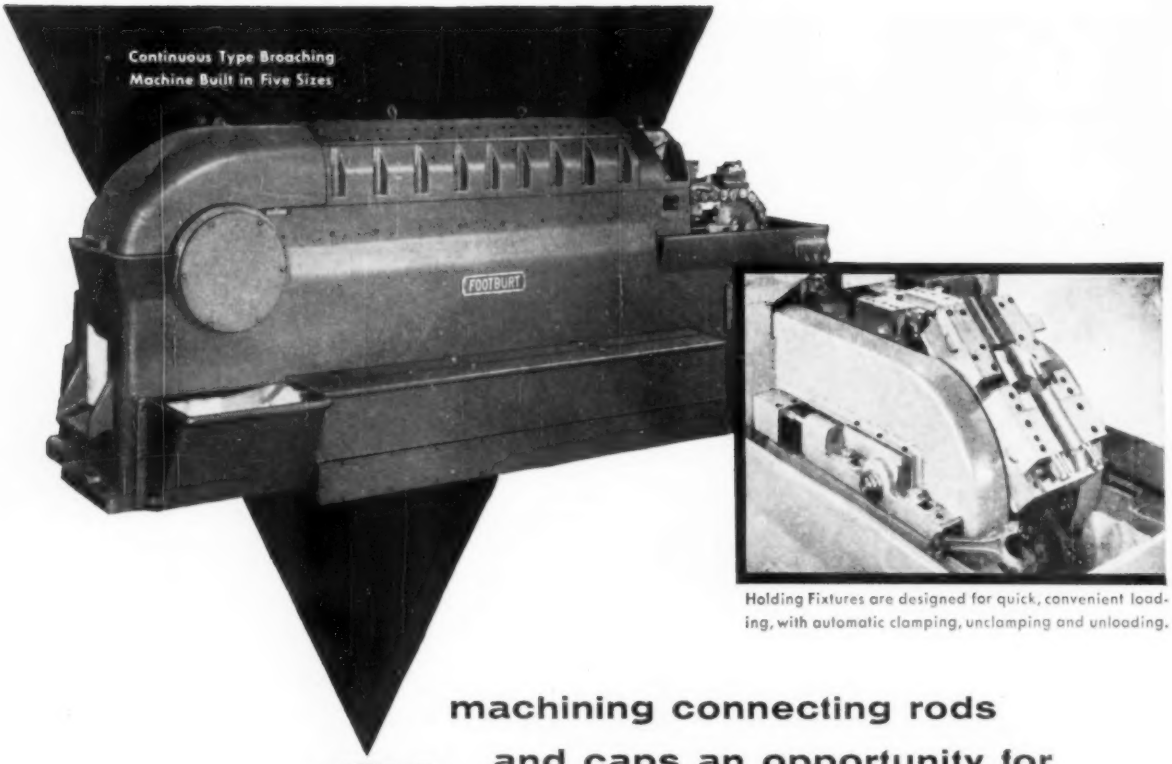
Just think what it means in the production of a part like this when one compact machine and one easily maintained set of tooling can handle *4200 operations* per hour to close limits, plus control inspections. Yet this is only one of many outstanding examples of Bodine practical aid to cost or quality-troubled manufacturers. Send us your next tough job . . . parts or prints . . . for production analysis. Write Dept. TE-12.

THE **Bodine** CORPORATION

BRIDGEPORT 5, CONNECTICUT

AUTOMATIC DIAL TYPE DRILLING, MILLING, TAPPING, AND SCREW INSERTING MACHINES.

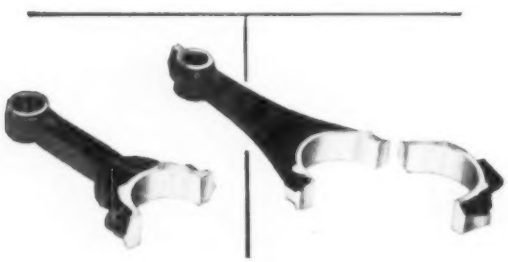
2BL058



Holding Fixtures are designed for quick, convenient loading, with automatic clamping, unclamping and unloading.

machining connecting rods and caps an opportunity for

Surface broaching



Surface Broaching is a modern machining method that in many cases shows reduced costs through higher production, finish to closer tolerance, and low tool maintenance costs. If you machine large quantities of duplicate parts we will be glad to work with you on the possibility of adopting Footburt Surface Broaching Machines. Send us blueprints and hourly production requirements for our recommendations.

THE FOOTE-BURT COMPANY CLEVELAND 8, OHIO

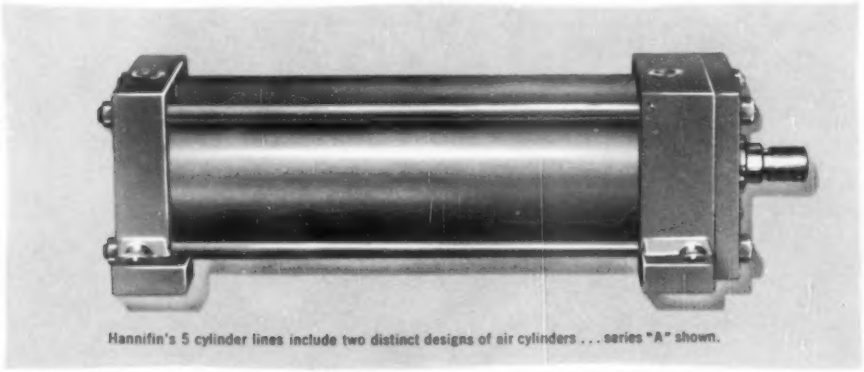
Detroit Office: 24632 Northwestern Highway, Detroit 35, Mich.

.....*Write for Circular No. 503*.....

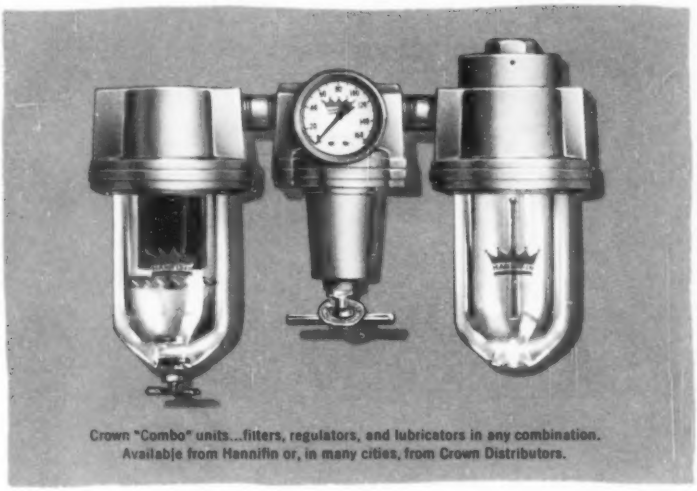
FOOTBURT

PIONEERS IN SURFACE BROACHING

PARKER-HANNIFIN FLUID-SYSTEM COMPONENTS

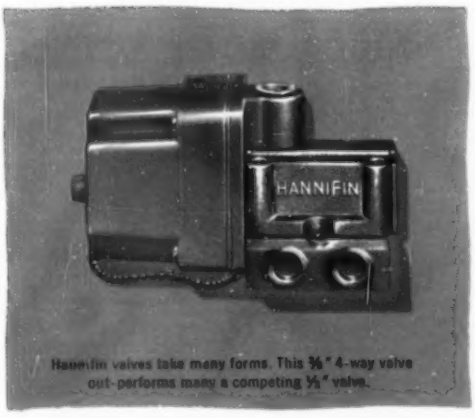


Hannifin's 5 cylinder lines include two distinct designs of air cylinders . . . series "A" shown.



Crown "Combo" units...filters, regulators, and lubricators in any combination. Available from Hannifin or, in many cities, from Crown Distributors.

Only **HANNIFIN** makes all these **AIR POWER COMPONENTS**



Hannifin valves take many forms. This ⅜" 4-way valve out-performs many a competing ½" valve.

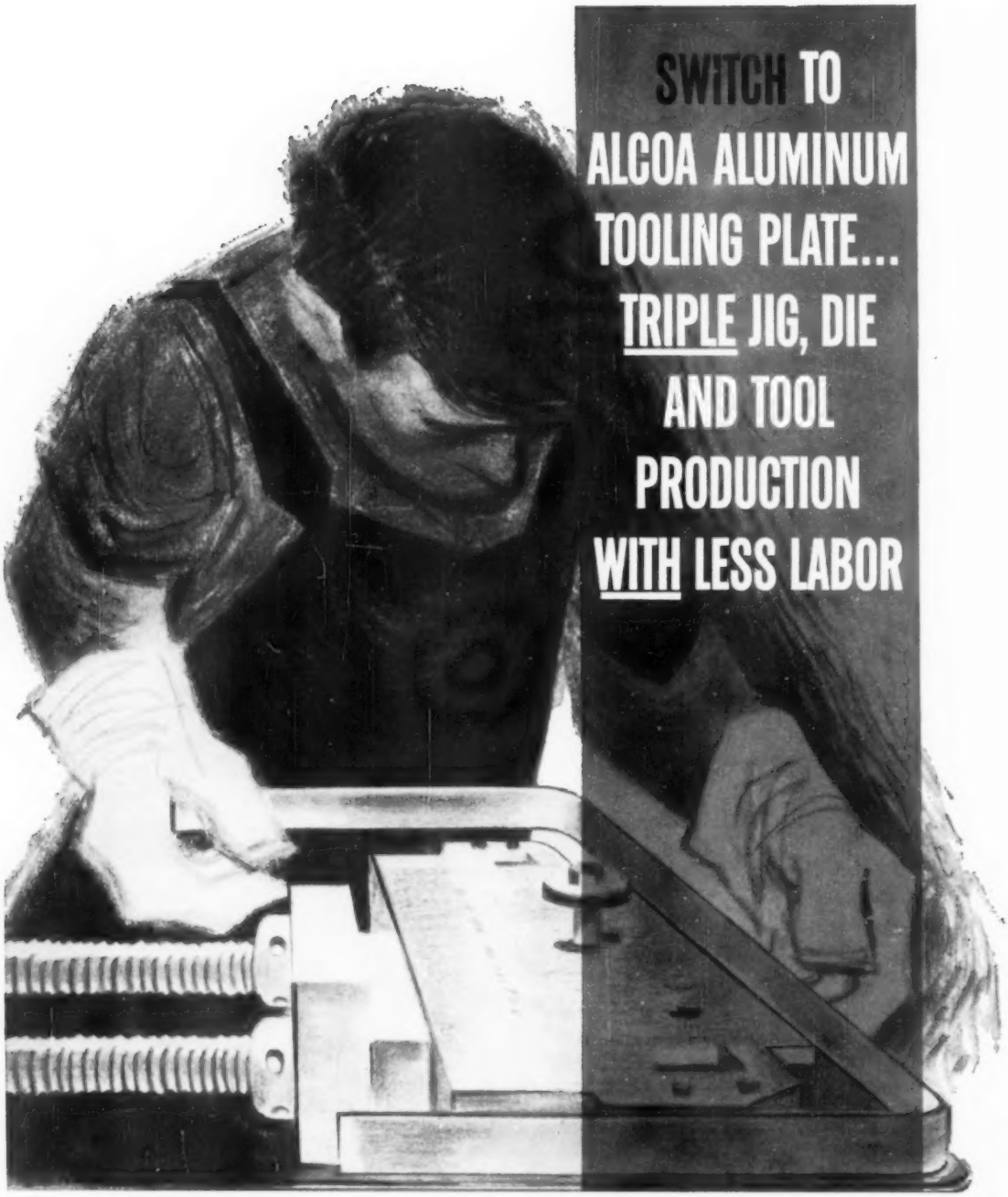
Anywhere you use compressed air to do work, Hannifin can help you. Hannifin cylinders for the "muscles". . . Hannifin air valves for any type of actuation, hand, foot, cam, solenoid, or pressure . . . the Hannifin "Crown" Line of filters, regulators, and lubricators for lasting air power efficiency . . . all are built by Hannifin to just one standard, the best.

Turn to Hannifin, too, for expert help in applying air power components. A Hannifin field engineer is as close to you as your telephone, wherever you are. Write us for his address—or, he's listed in the alphabetical section of Thomas Register. It's that easy.

HANNIFIN COMPANY

505 South Wolf Road • Des Plaines, Illinois

A DIVISION OF PARKER-HANNIFIN CORPORATION



SWITCH TO ALCOA ALUMINUM TOOLING PLATE... TRIPLE JIG, DIE AND TOOL PRODUCTION WITH LESS LABOR

That's a mighty big order for any shop, but Alcoa® Aluminum Tooling Plate and Alcoa Tool and Jig Plate can fill it. Here's a case in point. You can make three times as many core blower plates from 100 pounds of Alcoa Tool and Jig Plate as compared to the number obtainable from 100 pounds of conventional tooling plate. Now add these other savings: aluminum machines three times faster with better accuracy . . . machines and tools last longer . . . less maintenance is required.

Slash Labor Costs as Much as 60 Per Cent. Along with aluminum's high-speed machining characteristics, you get all-important light weight for savings in handling. Because it weighs but one-third as much as iron or steel, changeovers are reduced to a one-man job. An aluminum jig takes less time and work to open, close, move, store or set up.

Call Your Local Alcoa Distributor. Order locally from a wide selection of sizes and gages, cast or rolled. Alcoa Tool and Jig Plate is ideal for high-precision tooling needs. Alcoa 6061-T6 Tooling Plate is a wrought aluminum plate for high-strength utility requirements.

ALCOA ALUMINUM

Your Guide to the Best in Aluminum Value

Aluminum Company of America
950-M Alcoa Building, Pittsburgh 19, Pa.

At Pipe Machinery...

Times Change, But Never Ideals

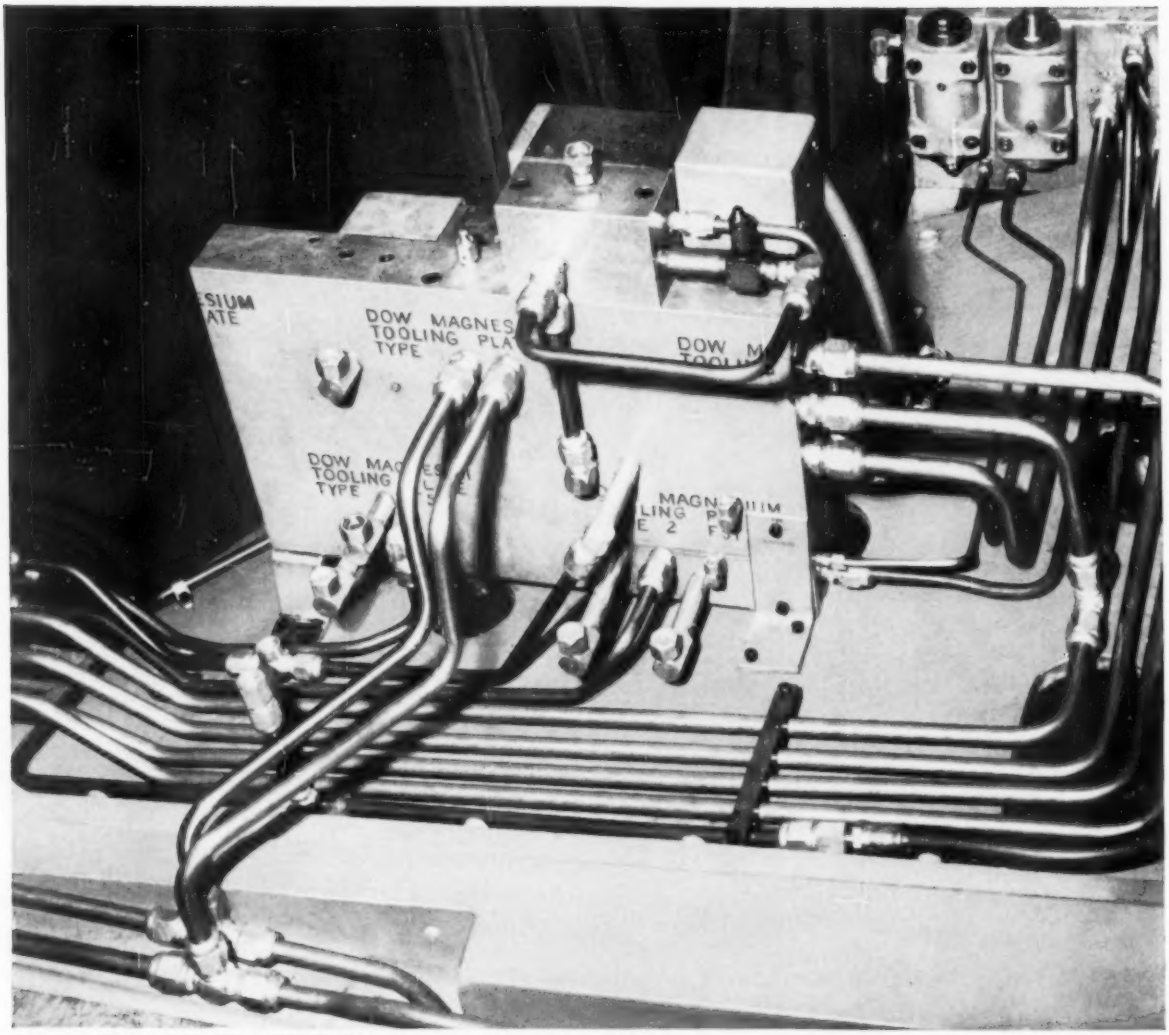
Quality, Precision and Service Are Still Our Watchwords

There's a world of difference between that simple one-room frame building where William G. Benninghoff started The Pipe Machinery Company in 1912 and our present spacious, well-equipped plant.

Yet, some things at Pipe Machinery don't change. We have never lost sight of the basic ideals of quality, precision and service which were the watchwords of our founder forty-six years ago. Today, every man and woman in our Gage Division is dedicated to the ideals of Mr. Benninghoff ...dedicated to the manufacturing of gages of unsurpassed accuracy and durability — and to their prompt delivery.

We invite you to get acquainted with our team of devoted craftsmen. Stop in and visit us next time you're in Cleveland.

THE PIPE MACHINERY COMPANY • *29100 Lakeland Blvd.* • *Wickliffe, Ohio* • *Greater Cleveland*



EXCELLENT MACHINABILITY *of Dow magnesium tooling plate permits economies in drilling the necessary holes (approximately 100) in this 20" x 12" block.*

"ROCKFORD" SAVES 20% ON MATERIAL COSTS WITH DOW MAGNESIUM TOOLING PLATE

The many advantages of Dow magnesium tooling plate are put to use in building control panels for hydraulic planers. Rockford Machine Tool Company of Rockford, Illinois, realized a 20% savings on material costs alone by using magnesium rather than other lightweight tooling metals!

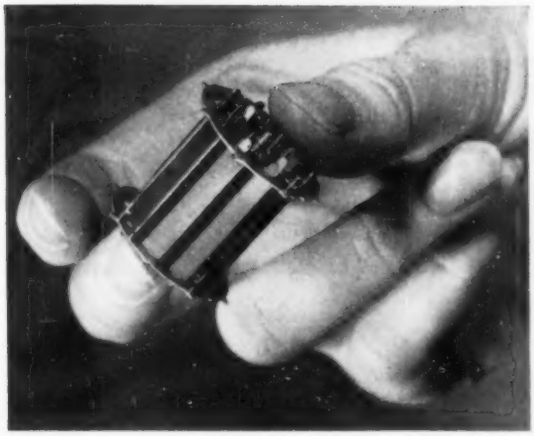
But the savings don't stop with the original purchase cost when you use Dow magnesium tooling plate. You actually save *twice:* once when you buy it and again when you use it. That's because magnesium is the easiest of all metals to machine—takes less time and less wear on tools to do the job. Magnesium tooling plate requires less machining because new closer tolerances assure better flatness and dimensional accuracy.

Next time you need a tooling metal try magnesium. You, too, will find it saves time, effort and money. Get in touch with one of the Dow magnesium suppliers listed below, or write us for more information. THE DOW CHEMICAL COMPANY, Midland, Michigan, Department MA 1431A-1.

AVAILABLE FROM STOCK AT

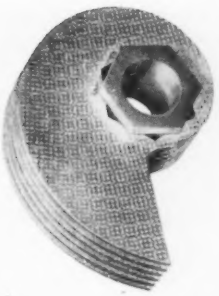
COPPER AND BRASS SALES, Detroit, Michigan
FULLERTON STEEL AND WIRE CO., Chicago, Illinois
HUBBELL METALS INC., St. Louis, Missouri
A. R. PURDY CO., INC., Lyndhurst, New Jersey
RELIANCE MAGNESIUM COMPANY, Los Angeles, California
VINSON STEEL AND ALUMINUM COMPANY, Dallas, Texas.

YOU CAN DEPEND ON DOW



▲ **Beam Switching Tube: 1 cathode, 10 targets, 10 spades to align.** This 21-element tube component had to be inspected fast enough to keep up with assembly speed in mass production, yet all elements had to be within .002″ of specification. Optical gaging with a Kodak Contour Projector provided the required speed and reduced inspection costs by spotting defects immediately after assembly.

Code Rod: 1100 holes to inspect. This steel tube, used in a high-speed printer, has more than 1100 tiny holes to be inspected for lateral and angular tolerances of ± .0015″. Conventional methods permitted inspection of 1 or 2 rods a day. With optical gaging the rate rose to 15-20 per 8-hour shift. ▶



▲ **Tuning Condenser: spacing parallelism.** Very close tolerances had to be held in spacing the parallelism of a special tuning condenser for electronic test equipment. Optical gaging with a Kodak Contour Projector permitted economical measurement to an accuracy impossible by other methods.

▲ **Wiper Spring: 24 dimensions . . . 3 minutes.** This vital component of a telephone dial switching mechanism has 24 dimensions to be checked. Inspection rate with a Kodak Contour Projector is 3 minutes per part, compared to an hour using mechanical gages.

One instrument inspects these varied parts

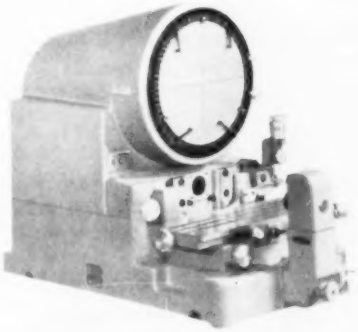
With optical gaging, switching from one type of part to another requires only a change of chart-gage and fixture. You can use the same basic instrument. And with a Kodak Contour Projector the variety of parts you can check is almost unlimited. Here's why:

• **Capacity**—Screen size does not restrict the size of parts you can handle. Multiple-position fixtures let you handle parts bigger than the screen itself. What's important is the staging area—and Kodak's unique relay lens provides uniform ample clearance regardless of magnification. Distortion-free image permits measurement anywhere on the screen.

• **Ease of operation**—Kodak Contour Projectors are designed for maximum speed and minimum operator training. Bright screen image reduces fatigue, permits working in normal room light. Finger-tip controls are within easy reach of the operator.

• **Optical Stability**—The accurately prepositioned optical elements on Kodak Contour Projectors eliminate the need for adjustments by operator. Rigidly mounted lenses and mirrors maintain alignment and position. Rugged construction withstands heavy use.

For more details on how optical gaging can save time and money in your operation, send for the booklet, "Kodak Contour Projectors."



Almost any inspection job can be done quickly and accurately on a Kodak Contour Projector. Operators need little training, work in comfort because controls are easy to reach; bright screen image reduces fatigue, permits use of instrument in normal room light.

Apparatus and Optical Division
EASTMAN KODAK COMPANY, Rochester 4, N. Y.

the KODAK CONTOUR PROJECTOR

Kodak
TRADEMARK

WHY BUY METAL YOU DON'T USE?

Switch to Allegheny Ludlum Cast-to-Shape Tool Steel

FORGING

Stepped-out forging for fabricating spinning cone: 2300 lbs.—$2691 material cost plus cost of machining.

CAST-TO-SHAPE

Cast-to-shape spinning cone 1059 lbs. $860.97 Includes cost of the pattern.

$1,831 Saved by changing to Cast-to-Shape

Why pay for metal that ends up as chips on your floor? Here are two fine reasons for switching to Allegheny Ludlum cast-to-shape tool steels.

CAST-TO-SHAPE MEANS YOU BUY FEWER POUNDS OF METAL.

Because the tool you buy is closer to its finished shape, you obviously spend less money on original metal. In the above example, the savings in metal cost alone amount to $1,894.

CAST-TO-SHAPE MEANS LESS FINISH MACHINING.

A casting like that above has only ¼ to ⅜ inches of machine stock on all surfaces, requiring very little machining compared to solid chunks. Cast-to-shape tooling is especially economical when working with intricate shapes.

Allegheny Ludlum, a tool steel producer who makes cast-to-shape materials, casts them with the same precise quality control for which their tool steels is known. A full line of cast-to-shape tool steel grades is available. You'll find ones with high resistance to abrasion, compressive strengths of approximately 400,000 psi, easy machinability, hardening with almost no distortion, toughness, high red hardness, and the capacity to take a high polish.

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in

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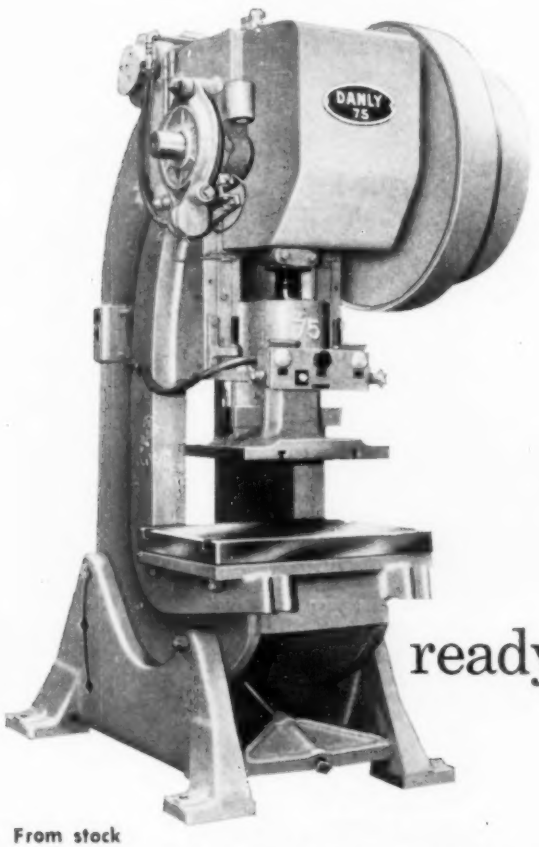

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Danly's Open Back Inclinable Presses bring big press efficiency to the small press field.

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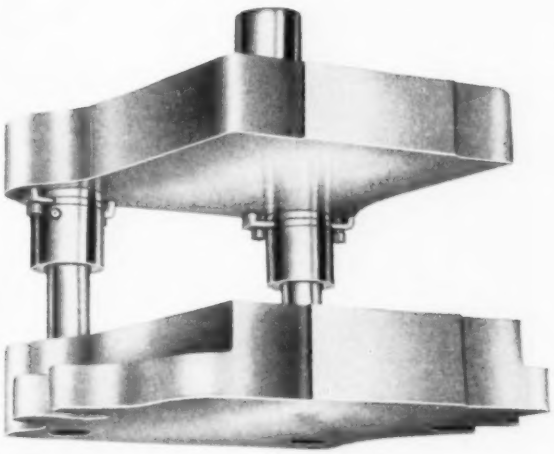
The ruggedness of heavy welded steel frame construction engineered into all Danly Presses, features this new O.B.I. line. The rugged construction throughout minimizes vibration, deflection and breakage. In combination with Danly Air Friction Clutch it assures long press life—continuity of production—accurate stampings—low cost of production and maintenance. This new line is priced for economy.

in

DIE SETS

and Die Makers' Supplies



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Stocked and assembled in 20 tool-making centers

Now all Danly Precision and Commercial Die Sets are assembled with demountable bushings and press-fit guide posts—to provide the most accurate die sets on the market. Chance of distortion is minimized. Posts and bushings are pre-fitted to dimensions, within tolerance, at the factory and furnished as matched units in all die sets. Pre-fitting is so accurate that bushings and guide posts are completely interchangeable.

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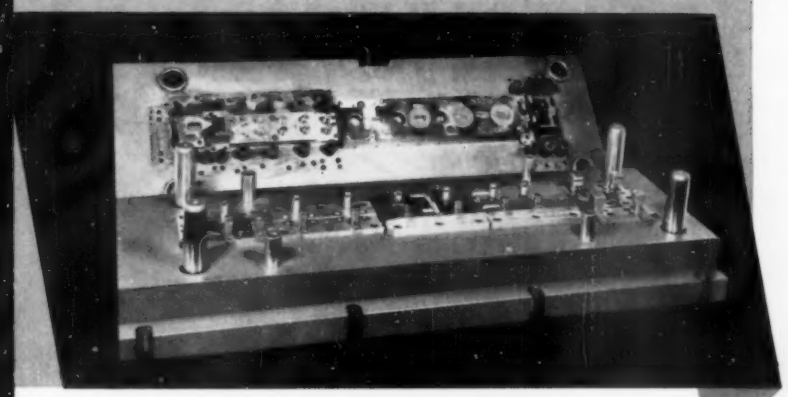

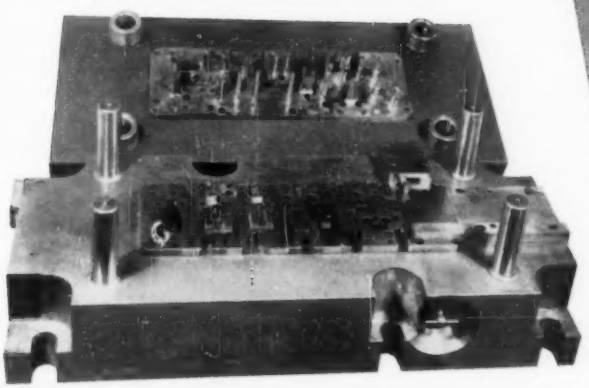

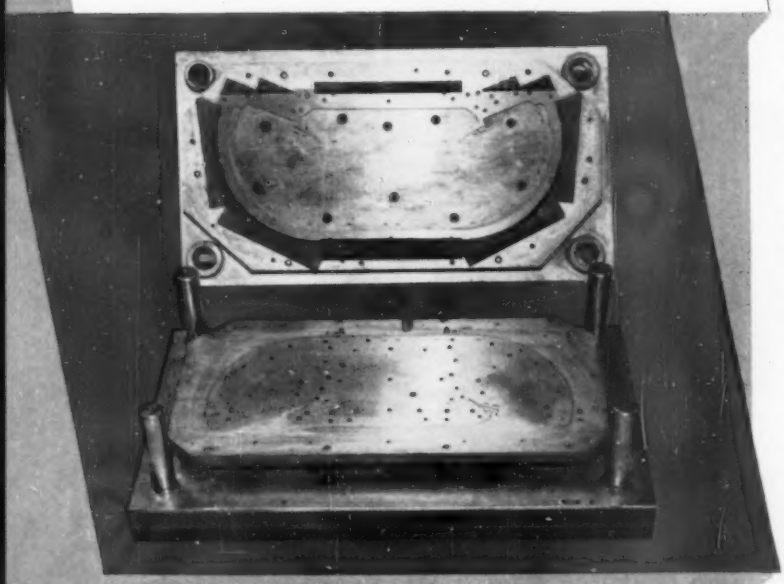

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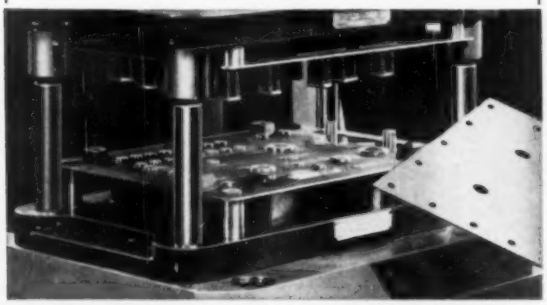

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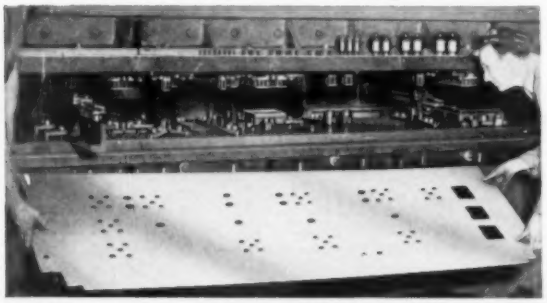

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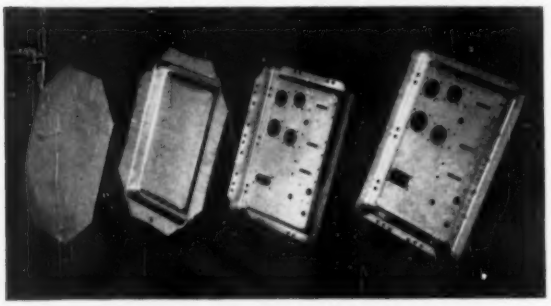

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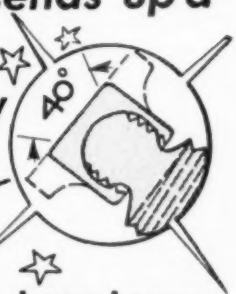

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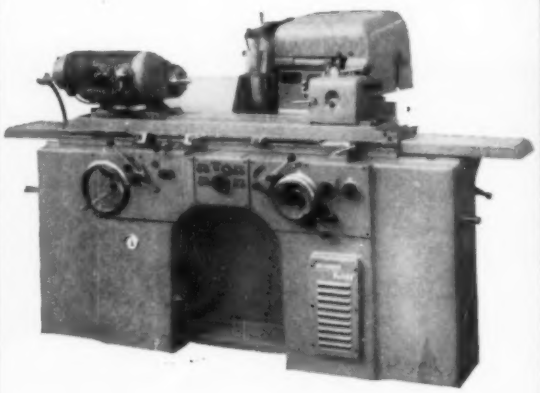

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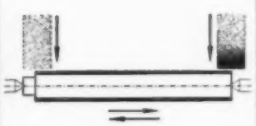

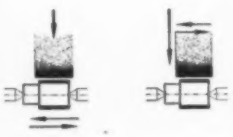

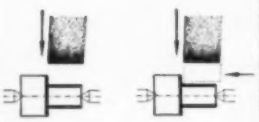

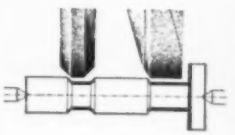

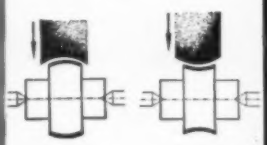

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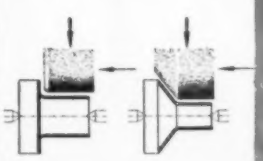

TUBE MILLS AND
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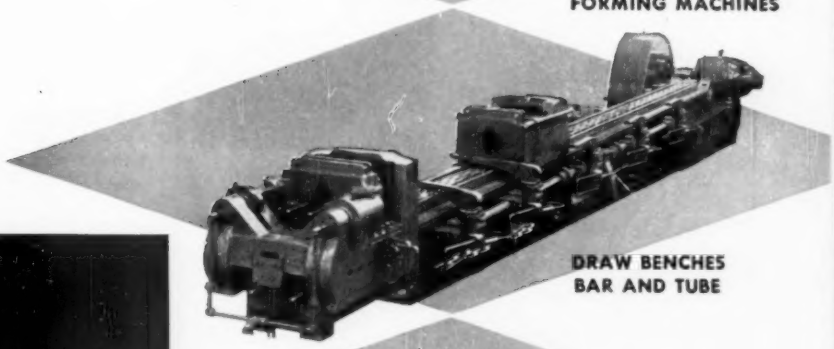

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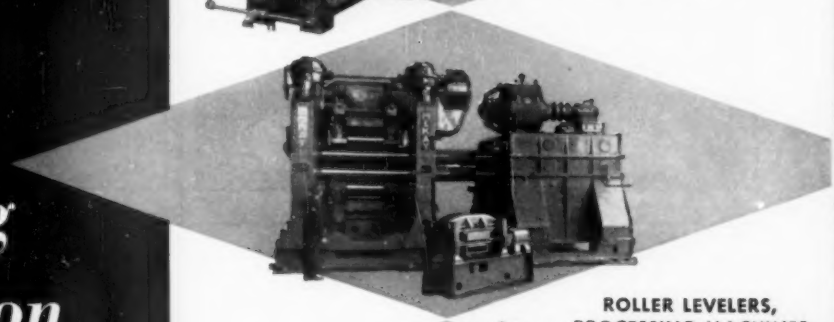

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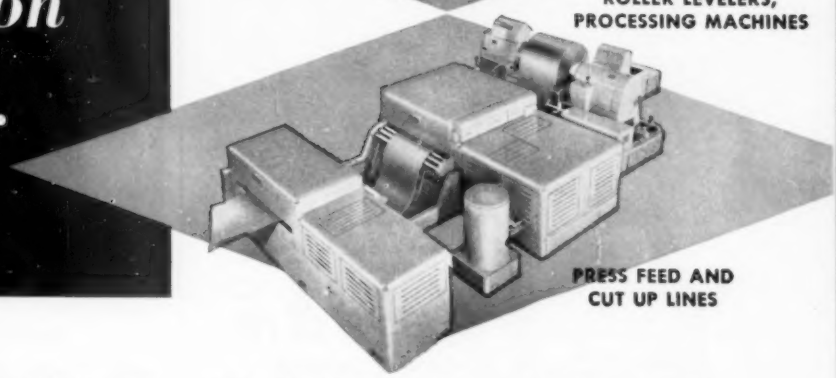

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Metal working Automation in action...

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McKay pioneered and has played a leading role in the development of such equipment as that pictured on this page.

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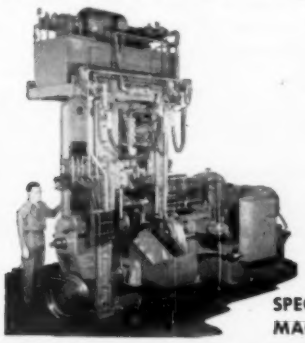

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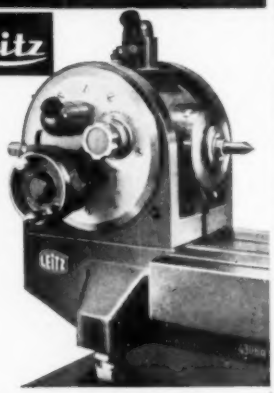

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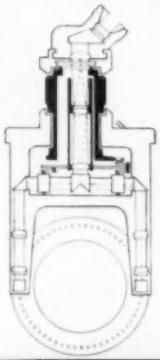

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2303D North 11th St. • St. Louis 6, Mo.

USE READER SERVICE CARD; INDICATE A-12-182-4

ANNOUNCEMENT

BY POPULAR DEMAND

MICRO MINIATURE END MILLS

are now available in 2 flute 3/64", 5/64", 7/64", 9/64" and 11/64" sizes from local stocks. Those former "SPECIAL" sizes are now "STOCK SIZES" offering the advantages of stock prices and deliveries.

When you think of small END MILLS—think of MICRO MINIATURES

DISTRIBUTORS IN PRINCIPAL CITIES

WOODSON TOOL CO.
4811 Lennox Blvd. Inglewood, Calif.

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"Far Superior to its Competition"...

. . . states Mr. Creighton Blanchard, toolroom superintendent at New Hampshire Ball Bearings, Inc., Peterborough, New Hampshire

THE NEW, IMPROVED THOMPSON TYPE D HAND FEED

SURFACE GRINDER

is winning enthusiastic approval wherever precision work is required

Here's what Mr. Blanchard has to say about the new Type D machine:

"We have three grinders in our toolroom—a Thompson and two competing machines. In our general toolroom grinding, especially on carbide and hard metals, we find the Thompson Type D so superior that we have recently purchased another Thompson just like it. All our precision work goes on the Thompson."

Compare these features

- Steel roller anti-friction slides eliminate ball creep and increase rigidity.
- 14" standard vertical capacity under 7" wheel at no extra cost with no loss in vertical capacity when using wet attachment.
- Solid support through entire length of bearing quill assures extra fine finish.
- 5 inch table movement per turn of handwheel improves quality of finish and speeds up operations.
- No backlash, anti-friction ball nuts and screws on cross feed prevent wheel from creeping away from work in shoulder grinding.
- Swing-out stop for table dog contact permits quick movement to wheel dresser.
- Immediate delivery available.

Send for descriptive literature on the new Thompson Type D Grinder.

THE THOMPSON GRINDER CO.
SPRINGFIELD, OHIO

"Keep Thompson in mind for that daily grind"

Thompson SURFACE GRINDERS

BELIEV IT OR NOT

this tube end just left the Patented **WALLACE** Combination Cutting and Deburring Machine!

Cuts like this in seconds!

. . . and you can do it in your own shop for lowest ultimate cost.

• WRITE for our FREE 44-pg. Wallace Cut-Machining book on cutting machines. 8 types — "tubes to plates."

Looking for answers? You'll find them here.

1958 Edition of "A MANUAL OF PROCESSES"

Cutting and bending. 200 pages — 148 illustrations. Answers thousands of troublesome shop questions. $3.00 plus 30¢ mailing cost. Send cash and save 30¢ postage.

ORDER YOURS TODAY!

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ACCURACY .0002 T.I.R.

.0002 T.I.R. or less at Spindle Nose, .0005 T.I.R. or less on Test Arbor six inches from Spindle Nose

SPINDLE SPEEDS 150 and 250 RPM Other Spindle Speed Pulleys Available

MODEL B943 MOTOR DRIVEN WORK HEAD

No. 11 B & S Tapered Spindle Standard Equipment. No. 12 B & S or No. 5 Morse Available at Slight Extra Cost.

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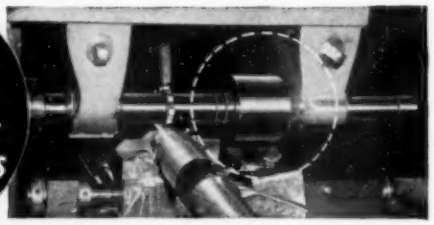
K. O. Lee Company, Aberdeen, S. D.

USE READER SERVICE CARD; INDICATE A-12-184-2

ELIMINATE MILLING MACHINE MAINTENANCE

OF ARBOR OUTER SUPPORT BUSHINGS



OFTEN UPS SPEEDS AND FEEDS 200%

Sound too good to be true? Then see how General Electric, Jeffrey Mfg., hundreds of others **absolutely end** arbor bushing maintenance problems and decrease production costs on horizontal milling machines by replacing the bronze outer support bushing with a Jergens "Live" Sealed Roller Bearing Unit as illustrated above. Jergens Units with adjustable roller bearings **hold** precision—permit increases in milling speeds and feeds to take full advantage of carbide cutters. The rigidity of these units increase cutter life and eliminate chatter, frozen bushings, and twisted arbors.

SEE HOW HUNDREDS SAVE THOUSANDS!

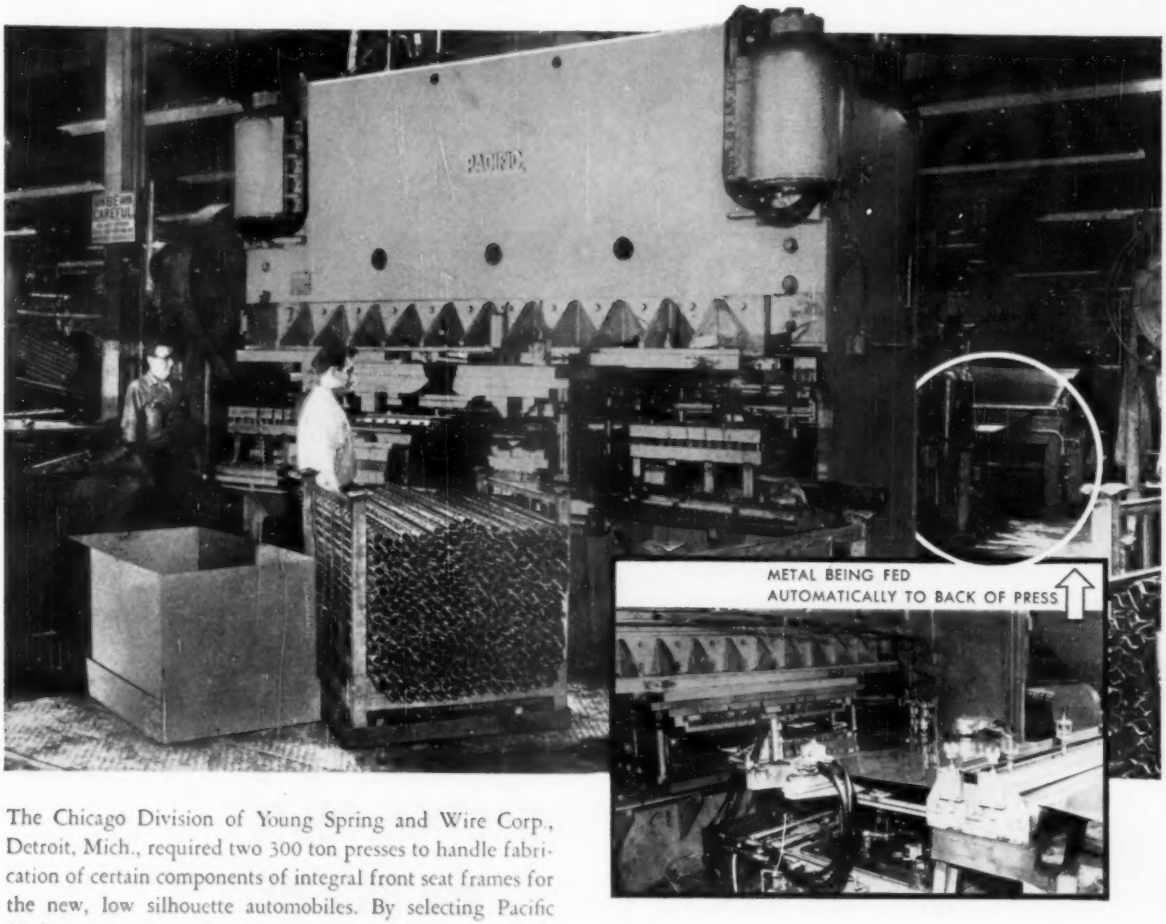
WRITE FOR ***FREE*** CASE HISTORIES OF ACTUAL company performance reports of jobs and dollars saved!

DONLEY PRODUCTS, Inc.

Dept. TE-12, 11106 Avon Ave. • Cleveland 5, O.

USE READER SERVICE CARD; INDICATE A-12-184-3

Hydraulic press brake reduces machinery and operational costs for forming large, heavy metal stampings



The Chicago Division of Young Spring and Wire Corp., Detroit, Mich., required two 300 ton presses to handle fabrication of certain components of integral front seat frames for the new, low silhouette automobiles. By selecting Pacific Hydraulic Brakes and using progressive dies coupled with an automatic material feeding system, it became possible to form major components of seat frames at each stroke of press. In a one-man operation, the first press stamps and forms the rear rail . . . the major component of the seat frame . . . from 57½" width material automatically fed through a 9-station progressive die from the back of the press to the front. The second press with two 4-station dies flattens and forms the ends of tubular material used for front seat, split-backs. Hydraulic system holds ram momentarily at the work to distribute tonnage evenly as punches enter material. Pressings are noiseless and extremely accurate.

Pacific Hydraulic Brakes actually cost less than conventional presses for this work. Pacific is a versatile tool profitable for any plant, large or small. It pays for itself from operational savings in blanking, forming, deep drawing, embossing, punching, straightening, stretching, extruding, hot forming or shearing. There is a Pacific Hydraulic Press Brake of the correct size to suit your needs.

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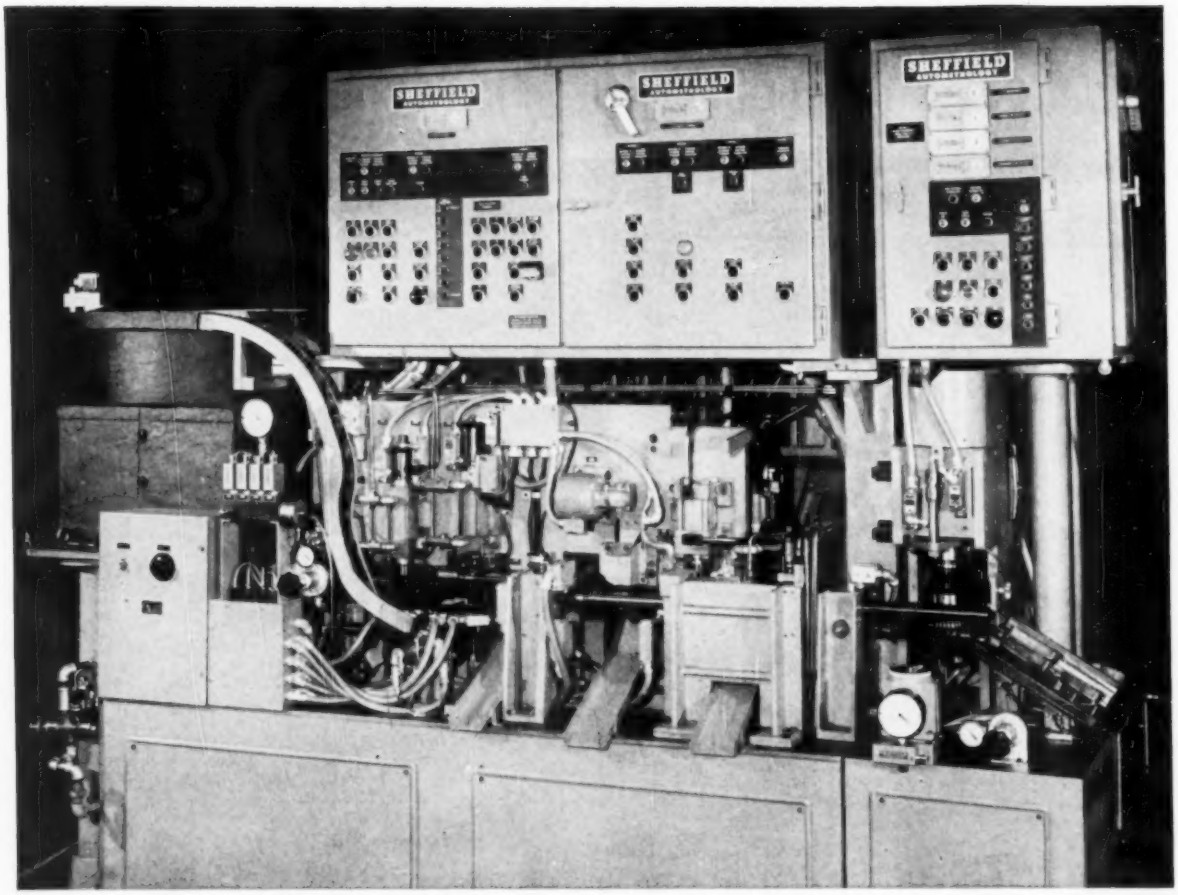

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COMBAT RISING PRODUCTION COSTS with AUTOMATIC GAGING and ASSEMBLY

Tapered roller bearing components are:

Gaged

Selected according to size

Assembled and—

The completed bearings given an operational test

ALL AUTOMATICALLY

Eliminated are the tedious hand operations and the scrap due to errors in judgement of both inspectors and assemblers.

This is one of the many cost-saving achievements of Sheffield's Autometrologists. Others involve any possible combination of Automatic Gaging with:

- Machine Control
- Sensing and Prediction
- Feedback
- Sorting by Classification Category
- Completely Automatic Assembly

If you contemplate reducing your costs through automation, utilize the ingenuity and resourcefulness of Sheffield's large staff of Autometrologists. Write to the Sheffield Corporation, Dayton 1, Ohio, U.S.A., Dept. 19.

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HEAVY DUTY OR COTTER PIN DRILLS
LOW HELIX OR DRILLS FOR BRASS
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DRILLS FOR PLASTICS
TEST RECORD

TEST after TEST

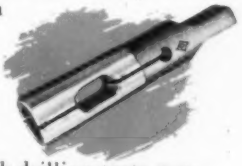
proves the economy of using CLE◇FORGE SPECIAL PURPOSE DRILLS

Time after time CLE-FORGE Special Purpose Drills have clearly demonstrated their ability to produce *more holes* at *lower cost,* as proved by hundreds of actual tests in customers' plants. Typical records show that CLE-FORGE Special Purpose Drills . . .

. . . produce 10 times more holes per grind . . . increase production 80% . . . double the number of holes per grind . . . cut cost per hole . . . eliminate breakage . . . speed production at no increase in tool cost . . . average 13,000 more holes per grind.

These are not "special" tools, but are stock drills at regular prices . . . available for immediate delivery.

For greatest economy, CLE-FORGE Special Purpose Drills can be ordered with tangs (at no extra cost) and used with CLEVELAND Split Sleeves. Instead of paying for a taper shank on every drill, you get the needed length with a CLEVELAND Split Sleeve—which outlasts many drills.



If you have a problem of high drilling costs, perhaps a CLEVELAND Service Representative can help you solve it with CLE-FORGE Special Purpose Drills. Contact our nearest Stockroom, or . . .

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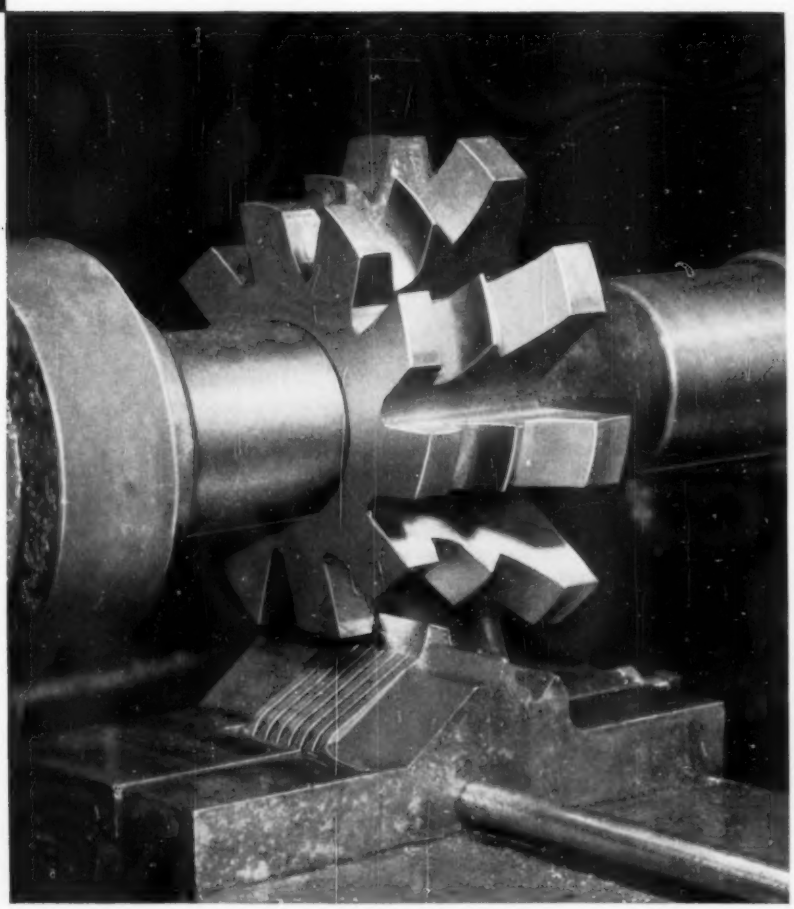
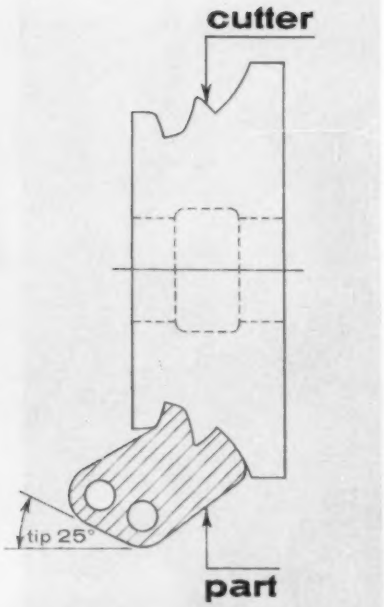
top cutter design
saves 50% in cutter cost,
reduces cutter breakage

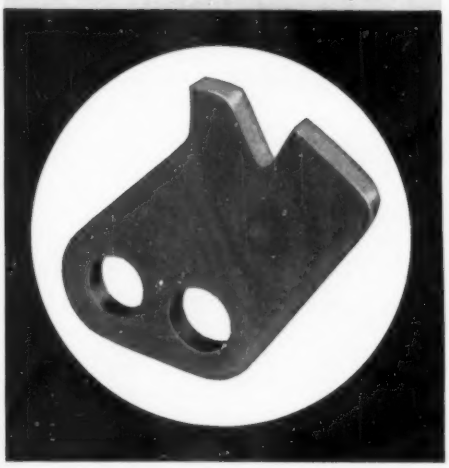
BARBER-COLMAN
recommends:

a single solid form relieved cutter to replace two former cutters

improved design to increase tool life and reduce cutter breakage







This Barber-Colman unground form-relieved milling cutter takes the place of two milling cutters formerly operated as a gang for milling these lever sectors. The proportions of the cutter were improved by reducing the cutter diameter and increasing the bore diameter. These improved proportions provide greater rigidity in the cutter and in the milling operation. As a result, initial cutter cost has been reduced 50%, and cutter cost-per-piece further reduced through extended tool life and reduced breakage.

The form on the workpiece is located with respect to the cutter axis to allow sufficient clearance behind all cutting edges. In this particular application, the workpiece is positioned at 25° relative to the cutter axis, permitting the manufacture of a one-piece cutter with adequate cutting clearance.

The material in the part is soft steel of maximum machineability. For best cutting efficiency, the cutter was designed with adequate clearance for milling this material. Cutters are 5″ diameter with 1¼″ bore as compared with previous cutters of 6″ diameter and 1″ bore.

Replacement with a single form relieved cutter has simplified cutter resharpening and reduced cost-per-piece. All Barber-Colman form relieved cutters are index sharpened across the face of the teeth. Cutters are simply and easily resharpened on conventional equipment or Barber-Colman automatic hob and cutter sharpening machines.

With Barber-Colman improved cutter design, pieces are milled at the rate of 3½″ per minute feed, and 150 R.P.M. cutter speed. Tool life averages 3,000 pieces per sharpening.

If you are seeking ways to improve your milling cutter efficiency, consult Barber-Colman cutter engineers. Their skill and experience in applying advance cutter design features will help to solve your milling problems.

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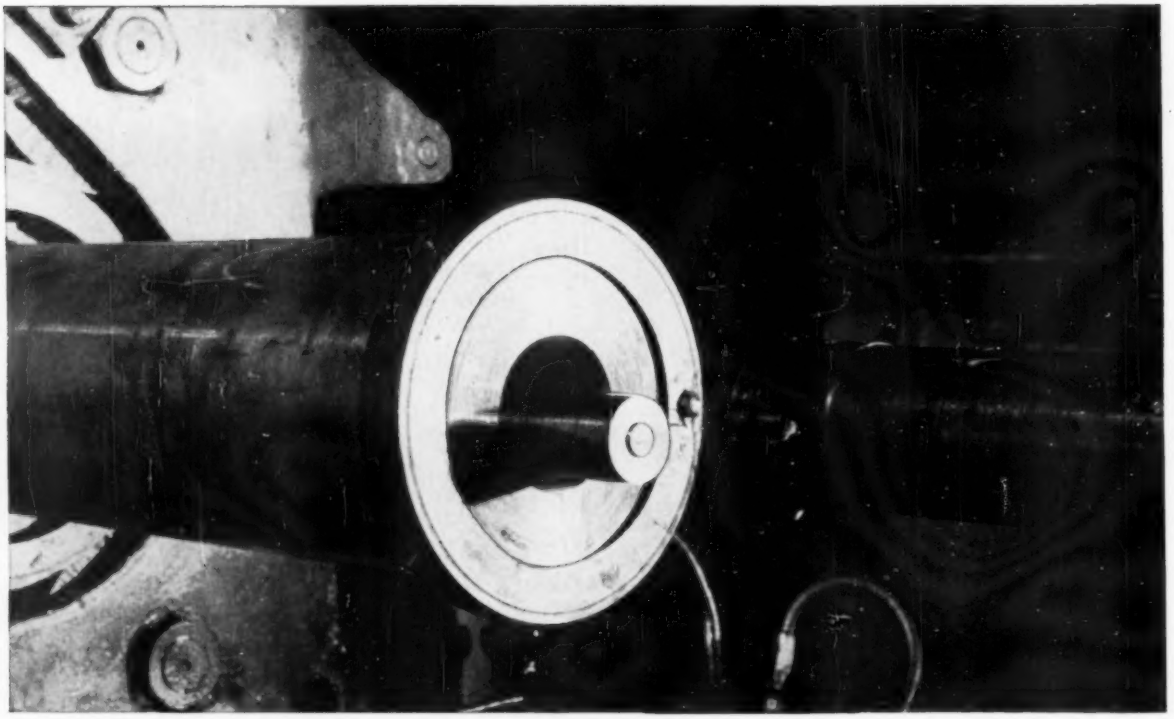
Hobs • Cutters • Reamers • Hobbing Machines • Hob Sharpening Machines

BARBER COLMAN



When only the best is good enough . . .

KENNAMETAL* is first choice to keep this half-million dollar lathe in operation

This illustration shows the end of a 30-foot drill collar that has been trepanned on one of the largest lathes in the country. When collars were bored in the conventional manner, the job took from 18 to 24 hours per piece. On this lathe, a minimum of three collars are bored per shift. This is not only one of the largest lathes, but probably one of the highest priced in use today. Machine time is charged at $50 an hour.

The payoff on this initial investment, and on the high machine-time-charge, comes from a couple of Kennametal carbide inserts that cost $1.50 each and three pads that keep the cutting head centered. These pads are also made of Kennametal and cost about $1 each. Less than $10 worth of tools keep this half-million dollar machine producing!

*Trademark

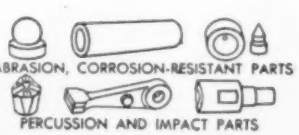
The inserts must withstand severe abrasive cutting conditions and high cutting-speed temperatures. The pads must possess unusual resistance to abrasion and deformation to prevent the slightest deviation of the head from the center line. In purchasing the tools, the owners are not only buying *cutting* ability, but *dependability*. The cost of any shutdown is so great that only the best tooling available can be justified. Every type of tool material . . . old and new . . . is continually being tested and evaluated. But nothing has been found, at any price, more reliable than Kennametal carbides.

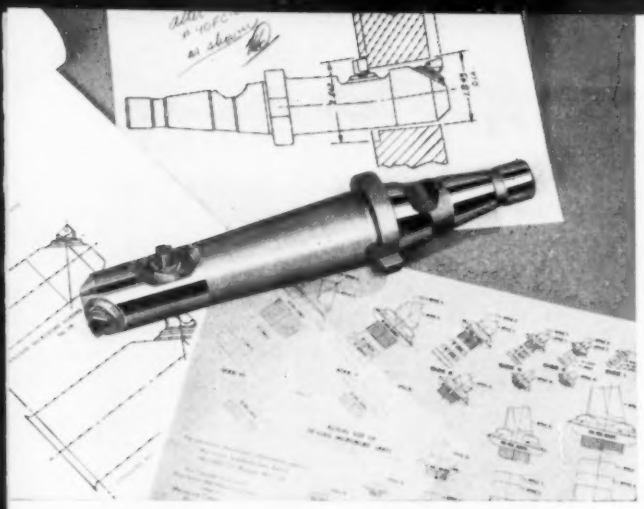
Kennametal cutting speeds and Kennametal dependability help make tool costs the lowest item in manufacturing costs. If you are looking for ways to cut expense and increase production, it will pay you to investigate what Kennametal tooling can do for you. Write KENNAMETAL INC., Latrobe, Pennsylvania.

Photo shows cutter heads used on lathe, also two sizes of Kennametal inserts, with K-2 pads to center cutting head.

3109

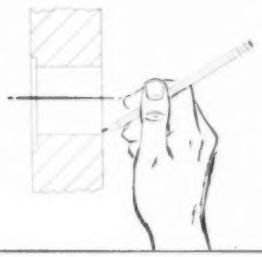
INDUSTRY AND
KENNAMETAL
. . . Partners in Progress



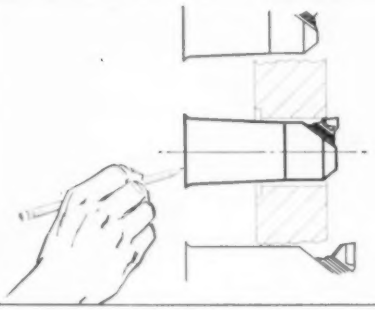


now, design your own semi-standard cluster tooling from stock Microbore components

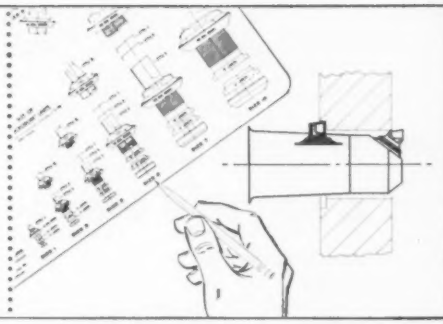
SIMPLE 5-STEP PROCEDURE



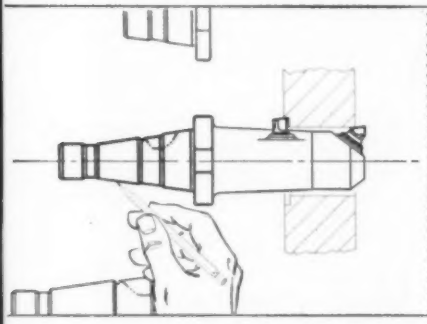
1 Make a full scale layout of bore to be produced, on tracing paper.



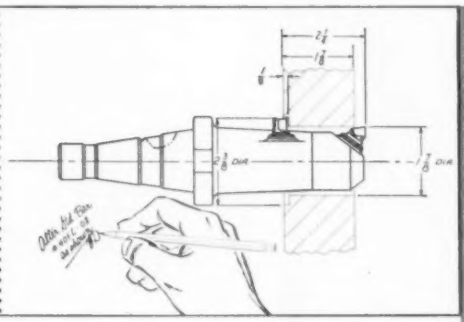
2 Place layout over standard bar nose templates. Select and trace the most suitable bar nose.



3 Select suitable Microbore Unit from template and trace in position for added tool station.



4 Trace the desired shank on boring bar, using shank template.



5 Microbore tool stations will be added to the standard Microbore Boring Bar as specified.

Simple cluster tooling designed in this manner costs little more than standard bars; substantially reduces delivery time, and is thus ideally suited for low-production applications.

NEW "TOOL DESIGNERS LAYOUT KIT" MAKES IT POSSIBLE!

Using transparent, full-size templates and a price index, it is now possible to design, pre-price and order your own semi-standard cluster tooling from stock Microbore components.

Any one of the several hundred standard Microbore Boring Bars may be converted into two- or three-tool cluster bars for such operations as boring, facing, counterboring and chamfering at one pass.

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☐ I would like a dealer demonstration of the design technique.

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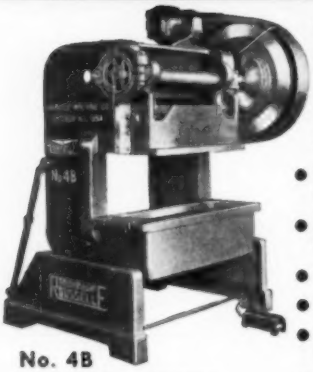
New 40-TON DOUBLE CRANK O.B.I. ROUSSELLE



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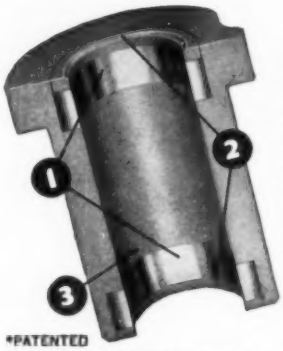

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1. Tungsten carbide rings at the points of wear; 2. Steel rings protect drills and carbide; 3. Special hardened alloy steel body.

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Carbide Inserted Bushings Are Doing It Daily!

How? Like this: (1) Last longer . . . with a life—in most cases—as long as solid carbide bushings at prices that approach the price of steel bushings; (2) Increased life for your drill jigs and fixtures; (3) Increased life for your drills and reamers; (4) Accuracy maintained for a LONG PERIOD of time; (5) Less non-productive machine time, less lost man-hours, because bushings need not be changed as often; (6) Inspection time saved, because of greater accuracy for a longer time; and (7) Less waste due to spoilage, for the same reason. Don't pass up a good bet! Get the dope on MEYCO Carbide Inserted Drill Jig Bushings today!

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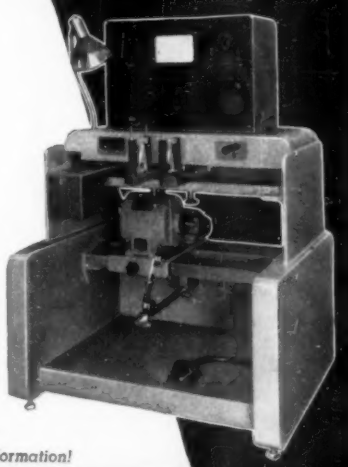

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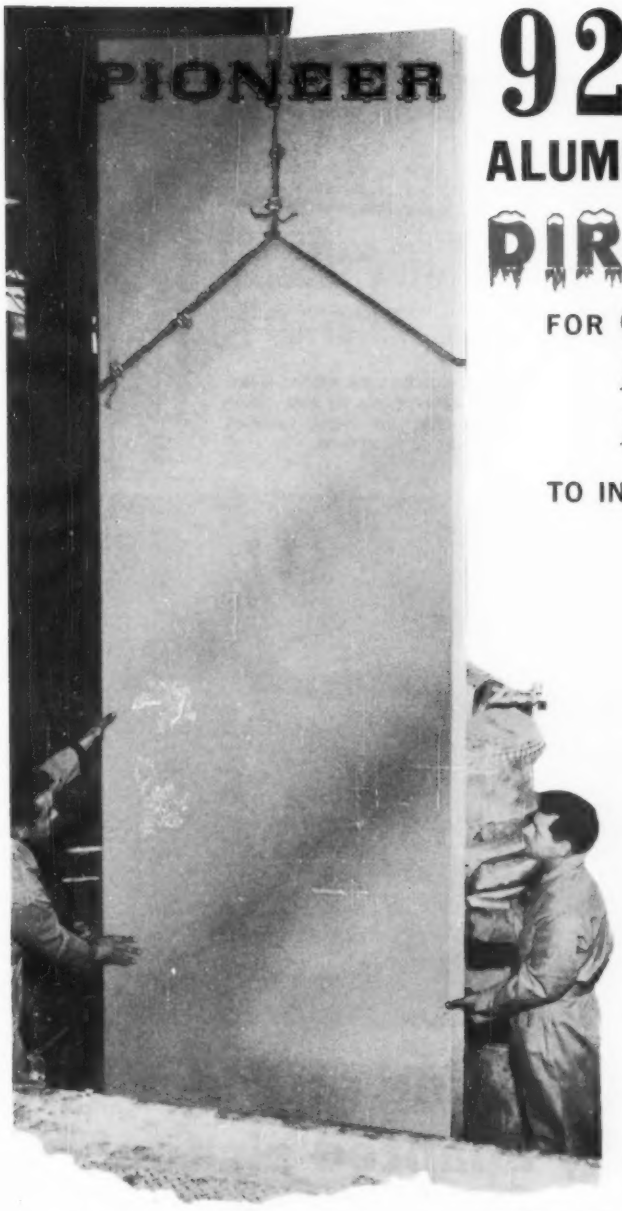

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ALUMINUM TOOLING PLATE

DIRECT CHILLED

FOR *Greater Density, Less Porosity and Improved Stability*

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2. PRECISE DIMENSIONS
3. SUPERIOR FLATNESS
4. BETTER SURFACE FINISH
5. LOWER COST TOOLING

These five outstanding advantages are possible because, starting with a finer grain structure and an inherent stability not approached in any other lightweight tooling material, each 921-T-*DC* tooling plate is machine finished to exact dimensions before shipment.

Not only is 921-T-*DC* being used by leading airframe, automobile, appliance and other metal working industries for jigs, fixtures and production tools, but is finding acceptance for use in the manufacture of precision equipment and components where close tolerances, uniformity and stability are prime requirements.

GET THE FULL STORY

• • • A complete description of Pioneer 921-T-DC; its versatility and adaptability; illustrations of applications, are contained in a new brochure available without cost or obligation through any of the Pioneer distributors listed below.

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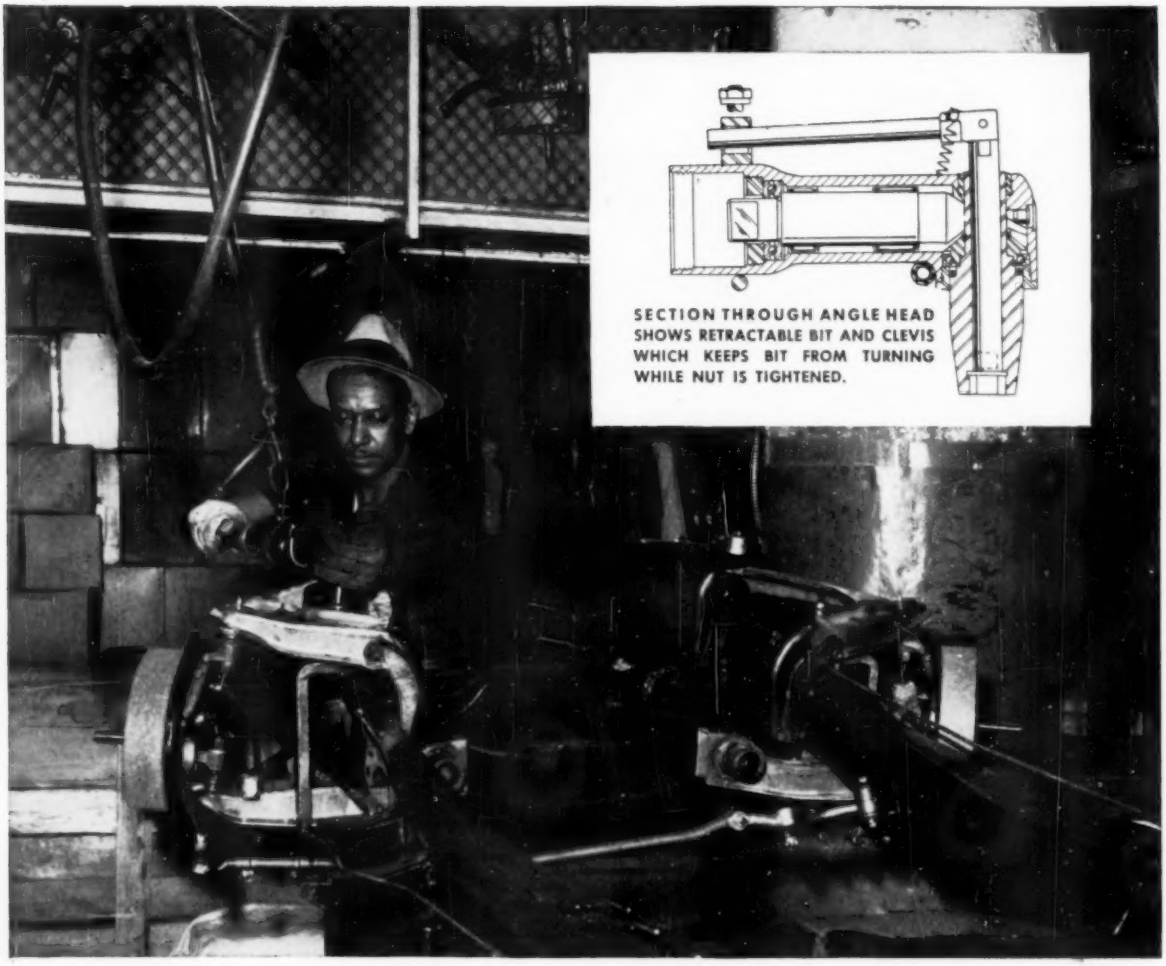

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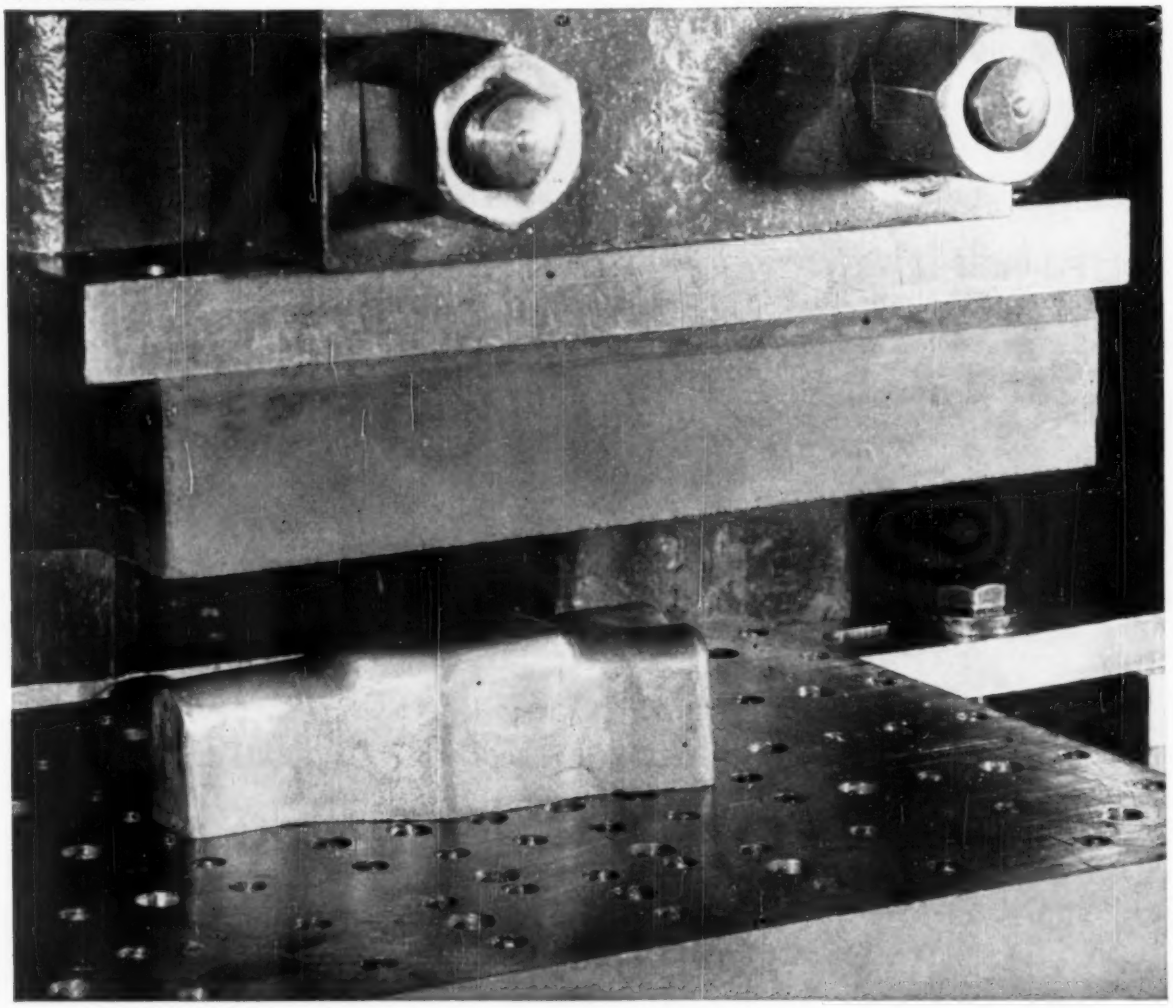

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Vol. 1 No. 1

Subject: The Hole You're Going to Tap:

There are many things affecting successful and economical tapping but none more important than the hole you're going to tap. This is a big subject — but here are some basic points to remember which can help you.

Tapping torque and chip removal, or chip volume, in a large measure determine tap life and production costs. Major influences are:

1. The hole size before tapping
2. The hole condition before tapping

Hole Size determines Percentage of Thread

Definition: "A percentage proportion of the basic height of thread:" The smaller the hole, the greater the percentage of thread. The greater the percentage of thread, the more the tapping torque — and the greater the volume of chips. This means increased friction and temperatures which cut tap life and require slower tapping speeds. Friction caused by chips packing in the tap flutes is a severe problem, particularly in deep hole tapping. These troubles can be largely avoided by careful selection of hole size.

Excessive Percentage of Thread — not a factor in strength or quality

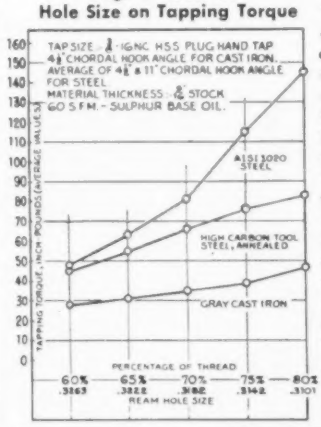
Percentage of thread specifications in Screw Threads for Federal Services Handbook H28, runs from about 53% for a No. 0-80 to about 74% on ½" diameter and larger. These percentages are adequate for the majority of work although special consideration is necessary in some cases such as stud fits.

Extensive tests show that the static strength for a length of engagement equal to a standard nut thickness reaches its maximum at 60 percent of thread. Therefore, greater percentages of thread cannot be justified on the basis of strength alone and can only be obtained at a sacrifice in tap life and efficiency.

Hole Size vs. Tapping Torque

Tapping torque increases with percentage of thread — but at a much faster rate than is generally supposed. In a recent series of torque tests it was found that in tapping AISI 1020 steel, the torque doubled when the thread percentage increased from 60% to 72% and tripled when the thread percentage was 80%. The increase was not so pronounced in annealed tool steel or cast iron, but the tests show that hole size is always a major consideration. (See fig. 1.)

Fig. 1 Effect of Hole Size on Tapping Torque


TAP SIZE - ½"-13NC H.S.S. PLUG HAND TAP
4½° CHORDAL HOOK ANGLE FOR CAST IRON, AVERAGE OF 4½° & 11° CHORDAL HOOK ANGLE FOR STEEL
MATERIAL THICKNESS - ⅝" STOCK
60 S.F.M. - SULPHUR BASE OIL
AISI 1020 STEEL
HIGH CARBON TOOL STEEL, ANNEALED
GRAY CAST IRON
TAPPING TORQUE, INCH POUNDS (AVERAGE VALUES)
PERCENTAGE OF THREAD
60% .3163
65% .3228
70% .3282
75% .3342
80% .3401
REAM HOLE SIZE

The reason for these sharp increases in torque with increases in percentage of thread can be found in the volume of chip removal. On a basic thread form a 50% thread height represents the removal of only 31.25% of the basic thread area, while an increase to 75% thread height increases the area to be removed to 60.9%—or, practically double the first amount. It can be seen that even relatively small decreases in hole size can materially affect performance by increasing torque due to chip removal and disposal. (See fig. 2.)

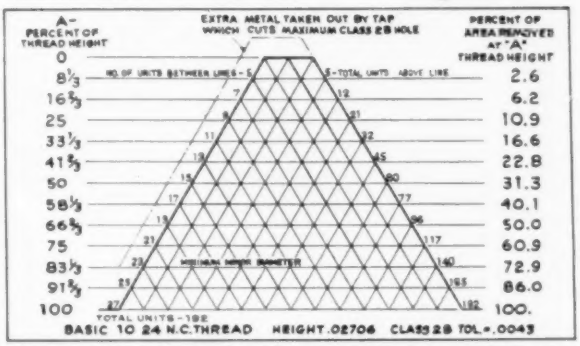


Fig. 2 Chip Volume in relation to Percentage of Thread

Hole Condition

In addition to hole size, great care should be taken so that holes will be properly prepared for tapping. The tap will have a tendency to follow the configuration and direction of the hole and if these are not reasonably accurate in relation to the tap axis and diameter, tap breakage, and holes that will not satisfy gages, will result. Conditions to be avoided are bell mouth or tapered holes, bent or crooked holes, out of round, torn or scored holes, holes with burrs, and holes with work hardened areas.

For a more detailed discussion of this subject (and particularly information on the diameter of holes which produce various percentages of threads) — fill out and mail attached coupon with 25¢ for technical brochure "Drilled Holes for Tapping" published by the Metal Cutting Tool Institute.

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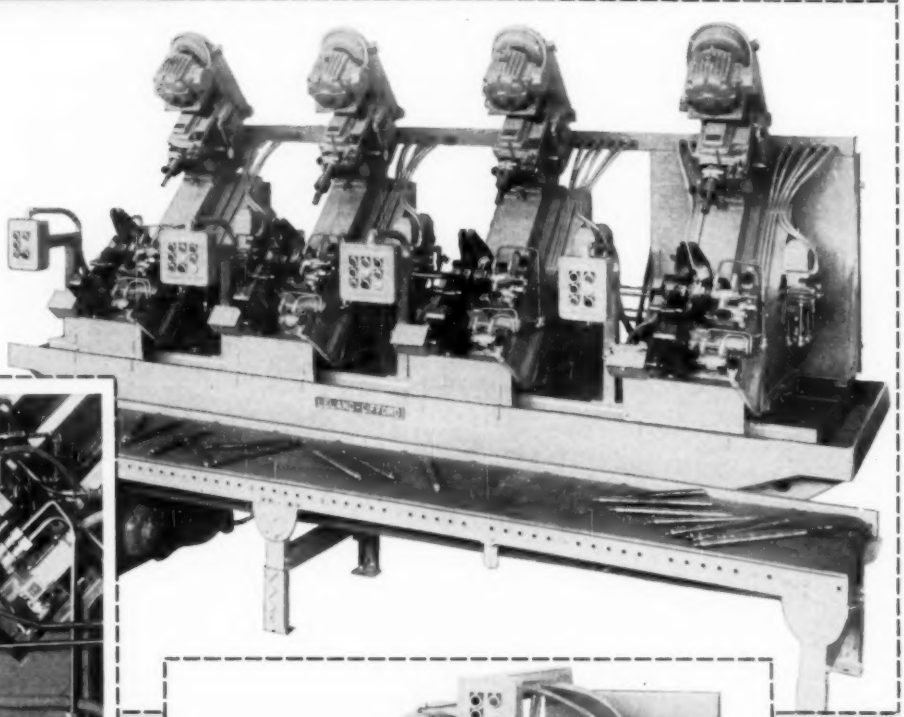

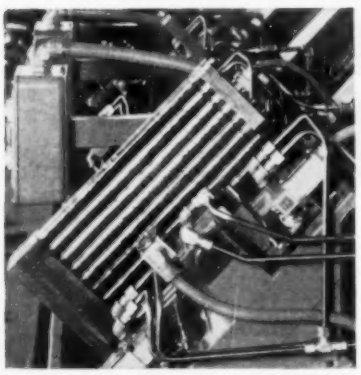

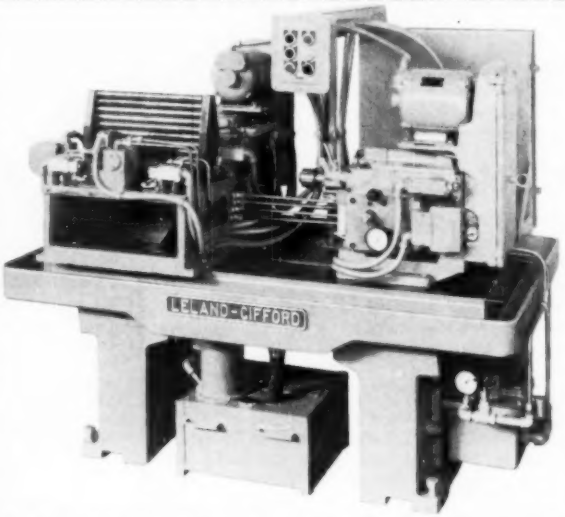

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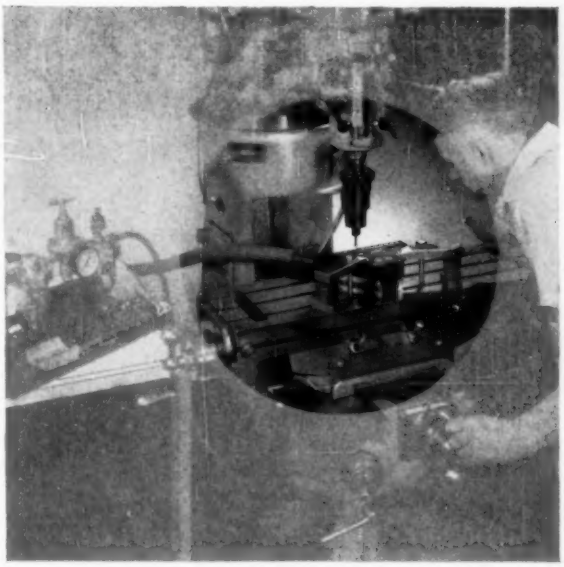

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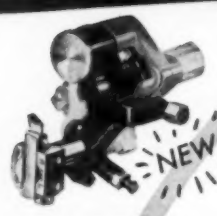
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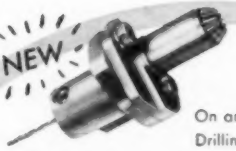
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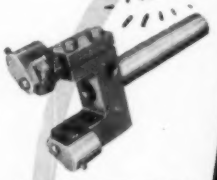
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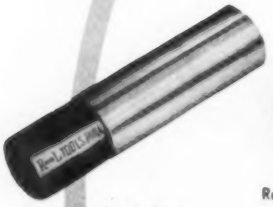
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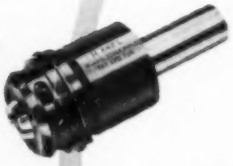
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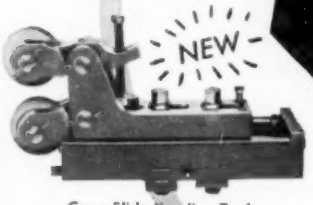
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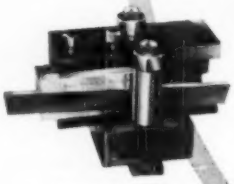
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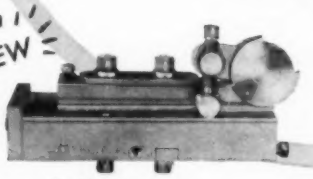
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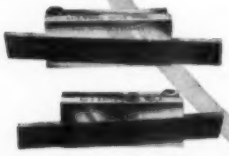
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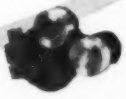
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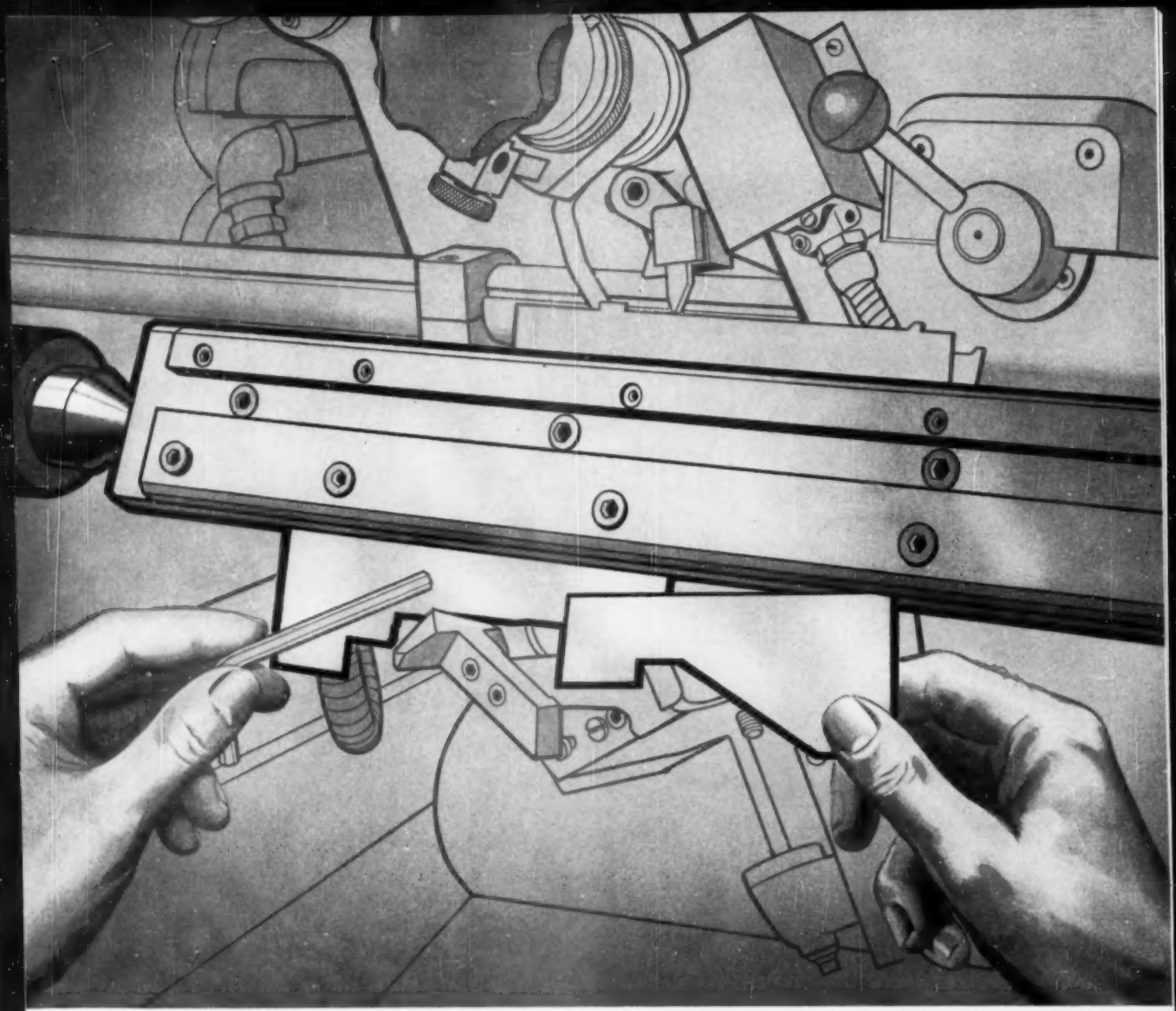

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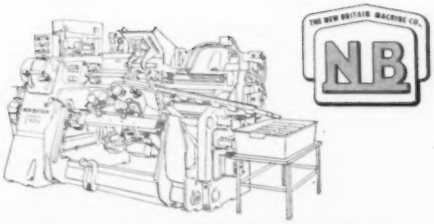

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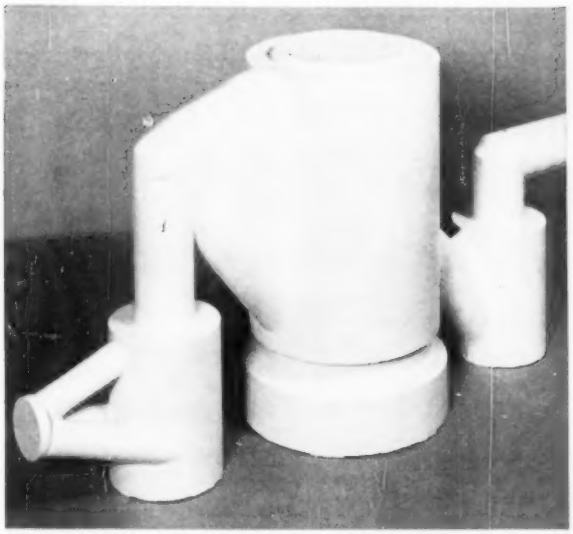

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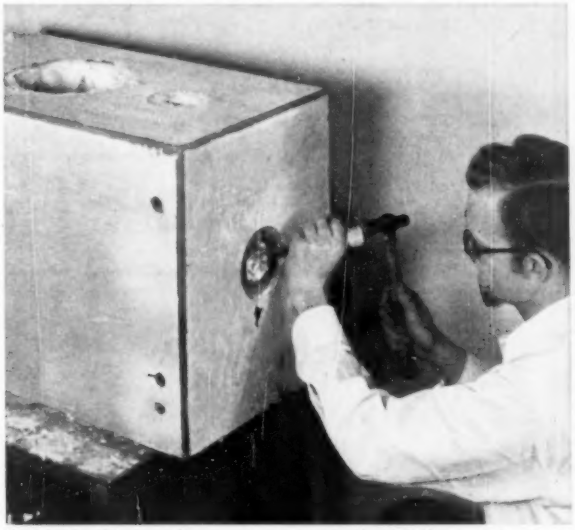
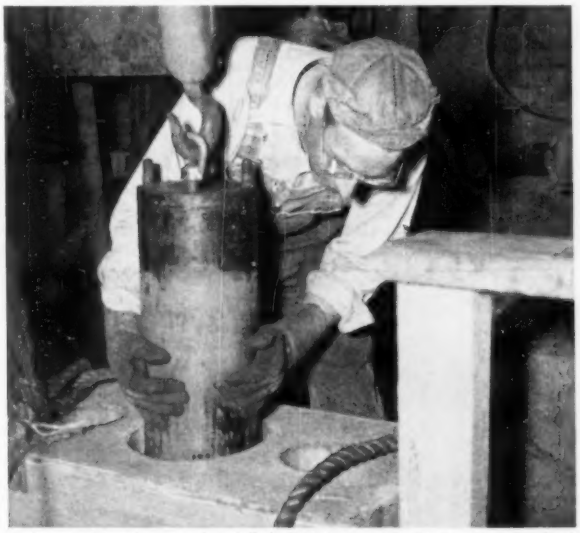


The plaster of Paris and Styrofoam material in the form is broken up and removed.



Main part of bromine pump is installed, ready to operate without wear or corrosion!

Dow Epoxies help stop corrosion for chemical processors

This corrosion-free pump block adds another to the list of success stories made possible by new, pure Dow Epoxy Resins.

For years the main parts of bromide liquor pumps have been made with machined soapstone. Performance was inconsistent; the slightest crack or seam proved disastrous. But now Dow Epoxies open a new era of efficiency and economy for the chemical processing and corrosion fields. Easily cast to shape without costly machining, the epoxy pump blocks are impervious to the chemicals involved and free from the internal flaws of soapstone.

Have you a corrosion problem where Dow Epoxies may help? Write for information and technical help. Dow is a basic producer of the raw materials used in epoxy production. In this way Dow provides raw materials with optimum properties to produce superior resins, to control quality carefully and to provide a narrower range of specifications in the finished resin—so necessary to uniform performance. For complete information and technical data on Dow Solid and Liquid Epoxy Resins, consult your Dow sales office. Or write THE DOW CHEMICAL COMPANY, Midland, Michigan, Coatings Sales Department 2265M-1.

EPOXY T.M.

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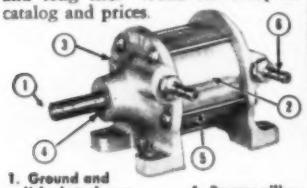
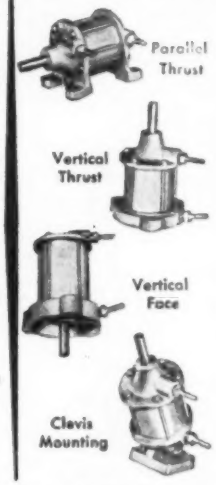
Low Cost . . . Compact . . . Powerful . . . Rugged

AIR-MITE Cylinders—made in single or double acting series—in 4 mounting types, are high quality cylinders at a low price. Simple, rugged design and compact construction give them long life, permit easy mounting on jigs, fixtures, tools, or machines. Used wherever power holding, pushing, pulling or lifting is required, AIR-MITE cylinders will meet your most exacting standards of dependability and long life. Write for complete catalog and prices.



1. Ground and polished steel ram
2. Brass, true-bore cylinders
3. High strength aluminum alloy cylinder heads
4. Bronze oilless ram bushing
5. Five steel tie rods
6. Brass hose stems

4 Mounting Types



AIR-MITE

4407A W. KINZIE • CHICAGO 24, ILLINOIS

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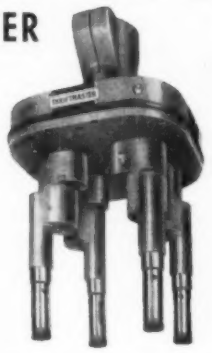
BOSS . . . you haven't walked me around the block for weeks, and you know what weak kidneys I have. Why don't you see your Threadwell Distributor for high performance cutting tools. You'll get home from the shop a lot quicker, and I won't have to lead such a man's life. *Photo by Cobb Shinn for Threadwell Tap & Die Co., Greenfield, Mass.*

USE READER SERVICE CARD; INDICATE A-12-204-2

Buy **THRIFTMASTER**

Double Eccentric Adjustable

DRILLHEADS



The only heads of this type standard with

Full Ball Bearing Construction

- greatest flexibility in drilling irregularly spaced holes
- sustained accuracy for trouble-free operation
- 20 Standard Models—3 to 8 Spindles
- Special Models on Order

Makers of
DORMAN AUTOMATIC REVERSE TAPPERS

Write today for complete information on this *dependable* Double Eccentric Adjustable Drillhead . . . the latest addition to the Thriftmaster line of Single Eccentric, Universal Joint Type Adjustable and Special Fixed Center Drillheads.

THRIFTMASTER
Products Corporation
A SUBSIDIARY OF THOMSON INDUSTRIES, INC.

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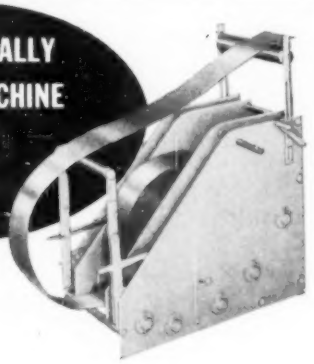
USE READER SERVICE CARD; INDICATE A-12-204-3

AUTOMATICALLY FEED ANY MACHINE FROM THIS SLACK LOOP



for greater accuracy and production!

Koil Kradles form a slack loop between coil and machine from which any automatic feed can freely draw! The slack loop eliminates drag and resistance of pulling against heavy coils. Reduced drag improves accuracy of any feed device . . . records show up to 80% more footage handled per shift!

Koil Kradle's variable timer delays shut-off up to 10 seconds after motor switch trips off . . . forms a new slack loop before stopping, eliminates many unnecessary motor starts and stops! Adjustable plates center various coil widths; reversible motor for rewinding; power driven rolls; anti-friction bearings and numerous other features!

ASK FOR CIRCULARS, sizes and prices. Stock widths up to 50", coil weights to 20,000 lbs.

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World's largest manufacturer of small punch presses and mills.

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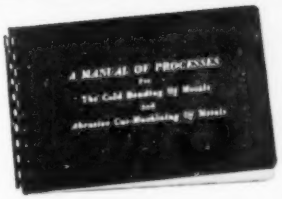
USE READER SERVICE CARD; INDICATE A-12-204-4

Answers to Hundreds of Bending or Cutting Problems



You can solve problems quickly with "A MANUAL OF PROCESSES for the Cold Bending of Metals and Abrasive Cut-Machining of Metals." 200 pages, 148 pictures.

You'll find clear, concise answers to: Why do bends wrinkle? Why do some bends break? What makes burrs in abrasive cutting? Why do abrasive wheels break at times? Which wheel is the right wheel? How fast can steel be cut? And hundreds of other shop questions.

Don't be a "head scratcher." Have the answers at your fingertips.

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ORDER YOURS TODAY!

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NEW RAVA ELECTRO-DYNAMIC BALANCING MACHINES

Accurate . . . sensitive . . . easy to operate . . . easy to setup—Rava answers the need for efficient, low cost static-dynamic balancing machines for production and small or mixed lots. Available from Tinius Olsen in capacities from a few ounces to a ton or more.

Write today for Bulletin 56.

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TO OBTAIN FURTHER INFORMATION ABOUT ADVERTISERS, TRADE LITERATURE OR TOOLS OF TODAY APPEARING IN THIS ISSUE OF THE TOOL ENGINEER, USE THE HANDY READERS SERVICE CARD ON PAGE 135.

DAD? You said you were coming home early. All the other kids' fathers are home. Why don't you use Threadwell cutting tools like they do? That's what Mommy told me to say. Grandpa is a Threadwell Distributor, you know. *Photo by Cobb Shinn for Threadwell Tap & Die Co., Greenfield, Mass.*

USE READER SERVICE CARD; INDICATE A-12-205-3

save tooling dollars

with this versatile, quick set-up

DUMORE®

AUTOMATIC "DRILL-N-TAP" UNIT

Only $825 *

Complete tool, ready to operate —includes reversing motor, electric tap control, pulleys, chuck.

Do all these operations—*and more*

TAP • DRILL • REAM • CHAMFER
SPOT-FACE • CENTER • DEBURR

NOSE MOUNTING BRACKET

Your Key to all-purpose machining—**anywhere.** It permits fast, easy mounting in any position, angle or direction in single set-ups, or multiple operations in sequence.

You can save hundreds of dollars in first cost alone with these DUMORE AUTOMATIC DRILL UNITS

SERIES 24 DRILL UNIT
Fully automatic with all controls built-in for short or long runs and frequent changeovers. From $613*
SERIES 26 DRILL UNIT
Same as Series 24 with just basic controls built-in for long, uninterrupted runs. From $505.50*
SERIES 20
Built-in adjustable controls—automatically selects proper speeds/feeds. No. 80 to 5/32" drill capacity. From $217.50*

*FOB Racine

Plug it in and it's ready to go

—Any unskilled laborer can learn to operate it in minutes. Once set, it's always set — minimizes scrap loss, drill breakage and eliminates operator fatigue slowdowns. Changes easily, quickly from job to job, operation to operation, for long or short runs. Precision engineering, famous Dumore quality workmanship and separate, isolated hydraulic and pneumatic systems provide trouble-free service over millions of cycles. Less than one cubic inch of air required . . . a cost-cutting feature.

The Dumore Series 28 "Drill-N-Tap" Unit

can be a drilling or tapping machine with just the flip of a selection switch. Tap fits into chuck, no extra attachments required. Reversing motor controls tap, eliminates troublesome clutches. Adjustable, positive spindle speeds from 265 to 4900 rpm. Can be set up for operation in 5 minutes—on drill press or special machine, with simple nose bracket. *For more details, send coupon.*

BUILDING-BLOCK ACCESSORIES FOR AUTOMATIC PRODUCTION

MULTIPLE SPINDLE ATTACHMENT fits units 28, 24, 26. For simultaneous drilling or tapping of 2, 3 or 4 holes. Quickly adjustable center distances.

COMPLETE DRILL PRESSES AND TABLE FIXTURES
Includes Circular and Rectangular Fixture Presses, Cross Arm Bar Assemblies, Circular Production Tables, Variety of Brackets, Control Components and other units to provide complete parts needed for building your own single or multi-purpose drilling or tapping machines for lower cost production.

AND THESE HANDY, USEFUL TOOLS

DRILL GRINDER, resharpens and precision points drills up to ¼".

MICRO-DRILL for drilling holes as small as .0001" diameter, without skilled operators.

HI-SPEED DRILL PRESS, hand operated, bench type, 0-⅛" capacity. And, DRILL SPEEDER, right, fits standard drill press, 17,000 rpm. 0-⅛" capacity.

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DRILLING UNITS • DRILL HEADS
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Faster Grinding — Longer Life

Whatever the job—cutting, rough grinding or finishing—there's a Manhattan Abrasive Wheel engineered to remove *more* metal, *faster* . . . at *lower* cost. Every component of the type wheel you specify—abrasive, grain size, hardness, structure and bond—is custom-designed by Manhattan for your particular requirements in cutting and grinding on steels, light metals and alloys. The result? More output per man hour . . . more production for your abrasive wheel dollar!

A Manhattan abrasive wheel specialist is prepared to help you determine the best wheel for your operations. Let him show you how to boost production and reduce costs with Manhattan high speed, heavy duty abrasive wheels.

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FOR FURTHER INFORMATION, USE READER SERVICE CARD; INDICATE A-12-207

MADE FROM

Time is short. Accuracy is imperative. Costs must be kept in check. These are problems you meet daily, and they're reasons why the aircraft industry has seized on plastic tooling. Here a tooling master for the Douglas DC-8 cockpit window area is laminated from glass cloth and tooling compounds based on BAKELITE Brand Epoxy Resins. When finished, its hard surface will endure repeated contact with production tooling for long periods without loss of accuracy.

BAKELITE *EPOXY RESINS*
BRAND

Plastic tools speed the DC-8

STRONG, LIGHTWEIGHT LAMINATES IMPROVE ACCURACY, REDUCE COSTS

At Douglas Aircraft Company, laminated tools made with glass cloth and compounds based on BAKELITE Brand Epoxy Resins have played a major role in production of the DC-8 and its predecessors. Epoxies result in "closer and more consistent dimensional control" than other materials. Douglas also reports fewer rejects, bringing important time savings. The tools are light in weight, easy to use, and fabricated in less time than would be possible with other materials. These factors add up to lower costs across the board.

And you will find many other reasons for the success of tools made with BAKELITE Epoxy Resins. These materials are the basis for tooling compounds that now have years of successful applications behind them. Write Dept. LH-06E, Union Carbide Plastics Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. In Canada: Carbide Chemicals Company, Division of Union Carbide Canada Limited, Toronto 7.

BAKELITE COMPANY
has a new name...
UNION CARBIDE PLASTICS COMPANY
DIVISION OF UNION CARBIDE CORPORATION

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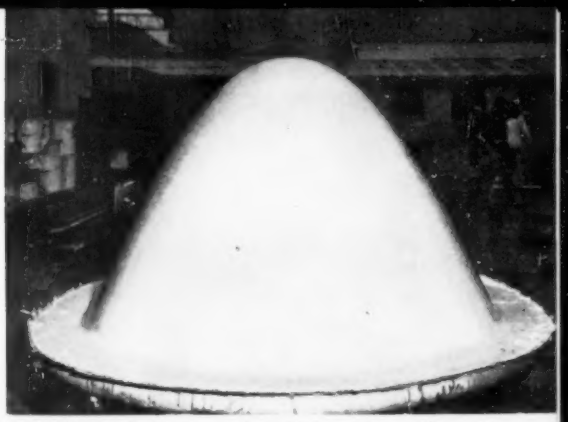
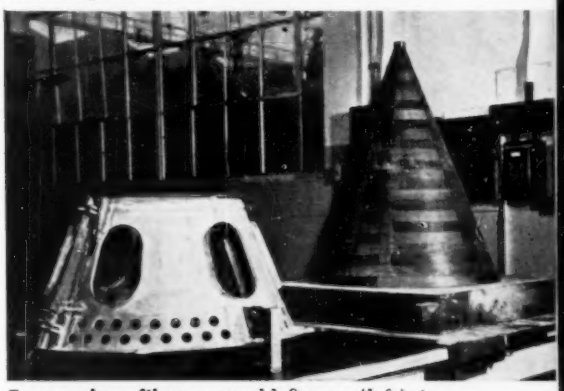
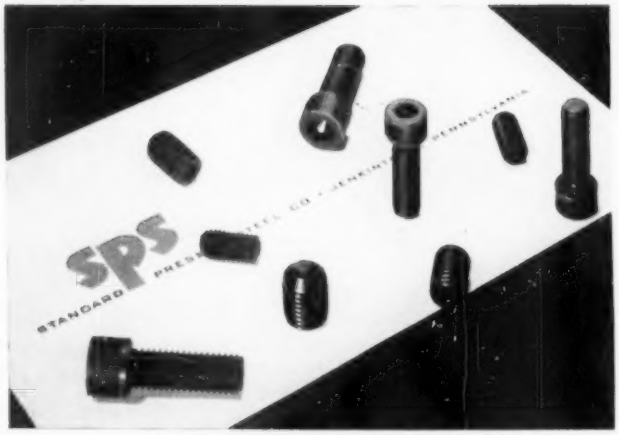


This lightweight epoxy female form die will be used in fabricating the DC-8 nose radome by the lost wax process. The form will be electroplated with nickel and heating coils will be installed in the reverse side to help cure the plastic nose radome.



Epoxy-glass fiber spotweld fixture (left) is shown with wood pattern around which it was shaped. Tools like this are quickly and easily constructed. Their light weight and great strength result in superior utility and service life.

Worker holds lightweight epoxy-glass "blue block" for checking a "Kirksite" drop hammer die in process of manufacture. Made by laminating against a part on a master pattern, it replaces similar metal blocks that weigh hundreds of pounds and require buffing and polishing to perfection.



Standard microsize UNBRAKO socket cap and set screws, #0 through #3, are supplied by your authorized industrial distributor in heat-treated alloy or stainless steel. Available with Nylok* self-locking feature.

Microsize UNBRAKO Socket Screws Simplify Fastening of Small Assemblies

Microsize UNBRAKO socket cap and set screws save both time and money in the design and assembly of your small devices. Precision manufactured, available locally, they eliminate the cost and delay of designing or procuring special screws to fasten tiny components. Use them in computers, servomechanisms, instruments, miniaturized electrical and electronic equipment—countless small, intricate devices where reduction in weight and bulk is required without sacrificing strength or reliability.

These miniature socket screws have all the advantages of larger UNBRAKOS. Deep, accurate sockets for non-slip, high-torque wrenching. Radii in socket corners to eliminate sharp angles where cracks start. Fully formed threads for greater strength and precision fit. Controlled fillets under cap screw heads to prevent shearing. Careful heat treat for maximum tensile values without brittleness or decarburization. Because of these features, microsize UNBRAKO socket cap screws are as much as 80% stronger than ordinary miniature cap screws, and microsize UNBRAKO socket set screws can be torqued tighter than ordinary miniature set screws. This extra strength means greater reliability in the fastening of your small assemblies.

For more information, see your authorized SPS distributor. He carries microsize UNBRAKOS in both alloy steel and stainless in sizes #0, #1, #2 and #3. Or write us for Bulletin 2055 and samples. Unbrako Socket Screw Division, STANDARD PRESSED STEEL CO., Jenkintown 37, Pa.

*T.M. Reg. U.S. Pat. Off., The Nylok Corporation

We also manufacture precision titanium fasteners / *write for free booklet*

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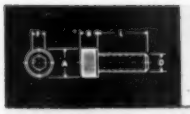


HEAT-TREATED ALLOY STEEL
Microsize UNBRAKO Socket Cap Screws
Class 3A Threads

Diameter		Threads per Inch NC	Threads per Inch NF	Length	Recommended Installation Torque in Inch-Pounds NC	Recommended Installation Torque in Inch-Pounds NF	Weight per 1000 in Pounds
#0	A .096		80	1/8		2.0	.21
	B .060		80	3/16		2.0	.22
	D .060		80	1/4		2.0	.26
	F .050		80	3/8		2.0	.33
#1	A .118		72	1/8		3.5	.31
	B .073		72	3/16		3.5	.36
	D .073		72	1/4		3.5	.42
	F .050		72	3/8		3.5	.53
#2	A .140	56		3/16	6.0		.54
	B .086	56		1/4	6.0		.61
	D .086	56		3/8	6.0		.76
	F 1/8	56		1/2	6.0		.91
#3	A .161	48		3/16	8.5		.77
	B .099	48		1/4	8.5		.87
	D .099	48		3/8	8.5		1.07
	F 5/64	48		1/2	8.5		1.27

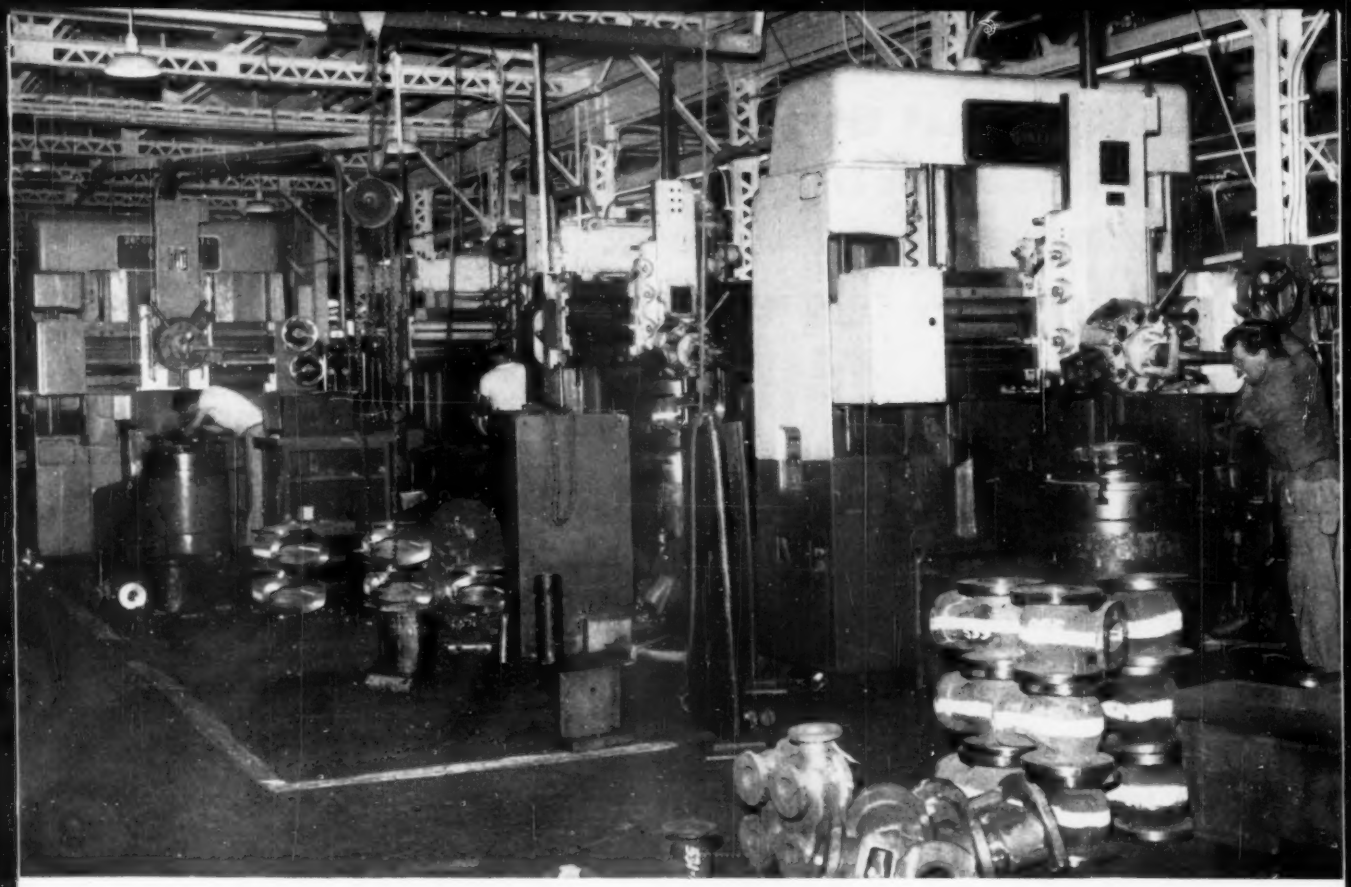
HEAT-TREATED ALLOY STEEL
Microsize UNBRAKO Socket Set Screws
Class 3A Threads—Plain Cup Point

Diameter		Threads per Inch NC	Threads per Inch NF	Length	Recommended Installation Torque in Inch-Pounds NC	Recommended Installation Torque in Inch-Pounds NF	Weight per 1000 in Pounds
#0			80	1/16		.5	.03
			80	3/32		.5	.04
	D .060		80	1/8		.5	.05
	F .028		80	5/32		.5	.06
			80	3/16		.5	.08
			80	1/4		.5	.11
#1			72	1/16		1.5	.04
			72	3/32		1.5	.06
	D .073		72	1/8		1.5	.08
	F .035		72	5/32		1.5	.11
			72	3/16		1.5	.13
			72	1/4		1.5	.19
#2		56		1/16	1.5		.05
		56		3/32	1.5		.07
	D .086	56		1/8	1.5		.107
	F .035	56		5/32	1.5		.15
		56		3/16	1.5		.19
		56		1/4	1.5		.273
#3		48		3/32	5.0		.10
	D .099	48		1/8	5.0		.135
	F .050	48		5/32	5.0		.18
		48		3/16	5.0		.235
		48		1/4	5.0		.32

HIGH RELIABILITY

SPS research is continually developing fasteners with higher and higher standards of predictable performance. By installing SPS high-reliability fasteners in your assemblies, you increase your overall product reliability.

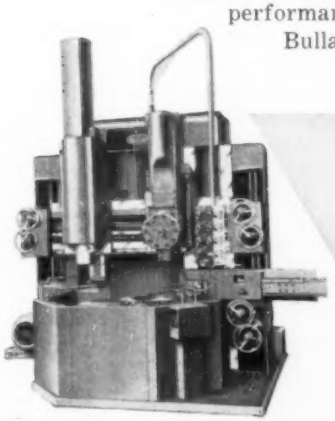
For more information on the full meaning of reliability, write for a copy of the new SPS booklet "High Reliability."



"they're GOOD machines"

BULLARD

A veteran of 39 years with the Newport News Shipbuilding and Drydock Company, Mr. L. G. Webb, Foreman, further said "a large volume of valve bodies, hubs or levers for hydraulic turbines and various other parts to be machined are handled most efficiently on our Bullard Model 75 Vertical Turret Lathes." Replacing Bullard V.T.L.'s of an earlier design, which gave them excellent performance, this company has a battery of ten Bullard Cut Masters, Model 75, ranging in size from 26" to 66".



The same dependable day-in and day-out cost cutting performance delivered by Bullard Cut Master V.T.L.'s, Model 75, can be applied to your machining work — have a Bullard Sales Engineer show you the many benefits of replacing your outdated equipment.

THE BULLARD COMPANY
BRIDGEPORT 9, CONNECTICUT

NOW...cut thousands of fine-pitch threads without breaking taps!

increase accuracy and production with...

NEW Scully-Jones reversible "SAFE-TORQUE®" TAP DRIVER

combines...

RELIABLE RELEASE

at the right torque every time...

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For Nos. 2 to ¼" tap range

right-hand taps only

with

FRICTION-FREE

overrunning roller drive

PROLONGS TAP LIFE—Gives you reliable release... precise control over torque. Releases instantly and completely below break strength of the tap. Preset torque release remains constant because sliding friction and heat are eliminated.

REDUCES MAINTENANCE—All contacting driving members roll on each other... eliminating heat and wear. Gear-type reversing mechanism requires no adjustment... produces little or no heat and is under load only when reversing.

INCREASES PRODUCTION—Operators gain confidence and step up machine speeds because there's no noise, vibration, or impacting. There's no slowdown for blind holes, no downtime for repairs.

PRODUCES BETTER THREADS—There's no thread distortion due to impacting or vibration. Driver starts releasing when taps get dull, preventing production of undersized threads. Tension spring permits tap to float in and out of hole... follows own lead without distorting threads.

ASK FOR FREE DEMONSTRATION—Your Scully-Jones representative or distributor has a sample reversible "Safe-Torque" tap driver with him to demonstrate on your "problem" jobs. Call him or write us: Scully-Jones and Company, 1915 S. Rockwell Street, Chicago 8, Illinois. For more information, ask for new supplement to Bulletin No. 20-50.

SCULLY JONES PRECISION HOLDING TOOLS

THE SOLUTION TO YOUR

"JOINT TROUBLE"

IS U. S. DRILL HEADS!

This is no "medicine man" talk! U. S. Universal Joint Heads have greater reserve stamina than you'll ever need! Heavy-duty joints are specially heat treated for greater capacity than rated . . . drivers and spindles have more than ample bearing . . . shaved gears insure smooth, quiet, full-power performance.

Get profit-making universal joint adjustability with U S. Drill Heads. Less downtime, quicker changeover, positive hole positioning. And, for long production runs, Slip Spindle Plates provide the advantages of fixed center heads.

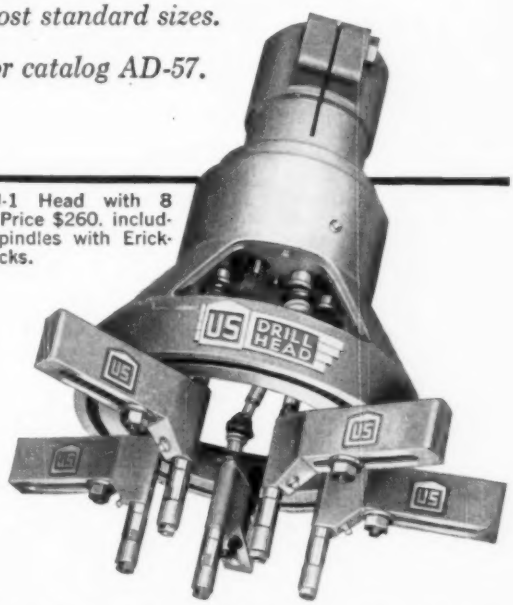
Immediate delivery on most standard sizes.

Write for catalog AD-57.

Only U. S. Drill Head provides a FULL RANGE of standard Universal Joint Adjustable Heads

Style Head	No. of Drivers	Drilling Capacity	Drilling Area (Dia.)
U-1	8	¼"	6"
U-1L	8	¼"	8"
U-1½	6	½" or ¾"	6"
U-2	10 or 12	½" ¾"	10" 9¾"
U-3	10 or 12	15/32" to ⅞"	12"
U-4	12	15/32" to 1-1/16"	15"

Style U-1 Head with 8 drivers. Price $260. including 2 spindles with Erickson chucks.



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Adjustable and Fixed Center Multiple Drilling Heads.
Individual Lead Screw Multiple Tapping Heads.

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HARDNESS TESTERS

WORLD'S STANDARD OF ACCURACY

ACCO for Better Values

EQUIPMENT for EVERY Hardness Testing Requirement

No matter what your hardness testing requirements are, there's a WILSON "ROCKWELL" instrument to do the job. Choose from this complete selection of hardness testers:

"ROCKWELL"—for most hardness testing functions.

Superficial—for extremely shallow indentations.

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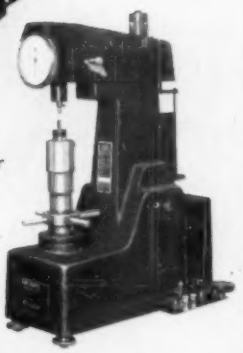

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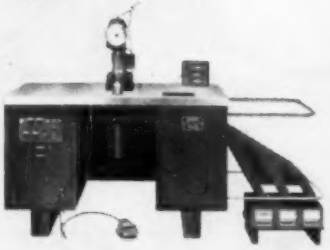

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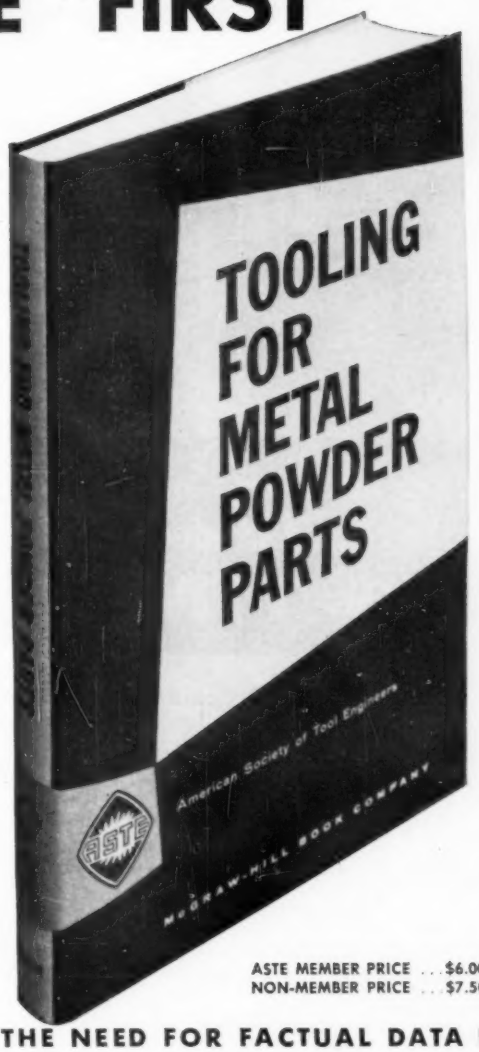

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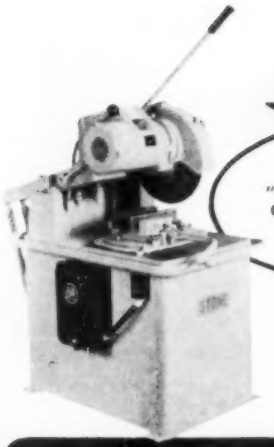

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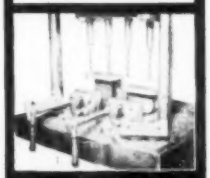

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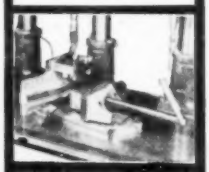

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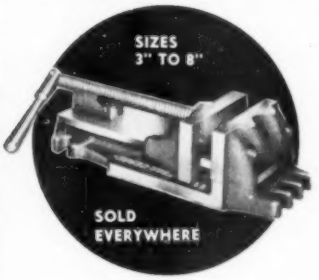

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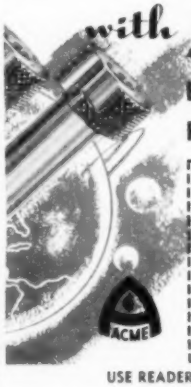

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Volumes 40 and 41

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*Atrax Co., The—Jan., Mar., May, Aug., Oct., Dec.
*Austin Industrial Corp.—Feb., Apr., June, Sept., Nov.
*Automation Devices, Inc., Perry Equipment & Eng. Div.—Mar., Apr., May, June, Aug., Sept., Nov., Dec.
Automation Devices, Inc., Vibratory Feeder Co., Div.—Feb.

B

Bakelite Co., A Div. of Union Carbide Corp.—May, Sept., Dec.
Baker Brothers, Inc.—Mar., May, July, Oct., Nov.
Balance Eng. Products, Inc.—Oct., Dec.
Balas Collet Mfg. Co.—Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Nov., Dec.
*Barber-Colman Co.—Feb., Mar., Apr., May, June, Aug., Oct., Dec.
Barber-Colman Co., Hendey Machine Div.—Sept., Oct., Nov., Dec.
Barnes Drill Co.—Mar., May, Sept., Oct.
Bath, John, & Co.—Jan., Feb., Mar., Apr., May, June, Sept., Oct. Nov. Dec.
*Bausch & Lomb Optical Co.—Aug., Oct.
Bausenbach Hydraulics—Apr.
Bay State Tap & Die Co.—Feb., Apr., Aug., Oct.
*Beaver Tool & Eng. Co.—Apr.
*Bedford Gear & Machine Co.—Feb., Mar., Apr., May, Sept., Oct., Nov.
Behr-Manning Co.—Feb., Apr., June, Aug., Oct.
Bellows Co., The—Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Nov., Dec.
Benchmaster Mfg. Co.—Aug., Oct., Dec.
*Bendix Aviation Corp., Controls Section—May
Bentley Ind. Corp.—Aug., Oct., Nov., Dec.
*Besly-Welles Corp.—Feb., Mar., Apr., May, Sept., Oct., Dec.
Bethlehem Steel Corp.—Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Nov., Dec.
Bijur Lubricating Corp.—Apr., Sept.
*Black Drill Co.—Feb., June, Aug.
*Blake, Edward, Co.—Jan., Feb., Apr., May, June, Sept., Oct., Dec.
Blanchard Machine Co., The—Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Nov., Dec.
*Bliss, E. W., Co., Press Div.—Jan., Feb., Apr., June, Aug., Sept., Dec.
Bliss, E. W., Co., Die Set Div.—Apr.
Bodine Corp., The—Feb., Apr., June, Aug., Sept., Dec.
Borg-Warner Corp., Rockford Clutch Div.—Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Nov., Dec.
Boston Gear Works—Feb. Apr., June, Oct.
*Boyar-Schultz Corp.—Apr., Sept., Nov.
Brightboy Industrial Products Div., Weldon Roberts Rubber Co.—Feb., Mar., Sept., Oct., Nov.
*Bristol Co., The—Jan., Apr., Oct., Nov.
*Brown & Sharpe Mfg. Co.—Feb., Mar., Apr., May, June, July, Sept., Oct., Nov., Dec.
*Brown & Sharpe Mfg. Co., Nelco Cutting Tools Div.—Mar., May, Sept., Nov.
*Bruning, Charles, Co.—Apr.
Brush Instruments Div., Clevite Corp.—Oct., Dec.
*Buck Tool Co.—Feb., Mar., May, Sept., Oct., Dec.
Buhr Machine Tool Co., Subs. Sidney Machine Tool Co.—Mar., Oct., Nov.
Bullard Co., The—Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Nov., Dec.
Burgmaster Corp., Small Tool Div., Burg Tool Mfg. Co., Inc.—Apr.
Butterfield Div., Union Twist Drill Co.—Jan., Feb., Mar., May, June, Sept., Oct., Nov.

C

Cadillac Gage Co.—Jan., Mar., May, July, Sept., Nov.
Can-Pro Corp.—Mar., May, July, Sept., Nov.
Capewell Mfg. Co.—Apr., May, July, Sept., Nov.

Carborundum Co., The—May
Card, S. W., Div., Union Twist Drill Co.—Jan., Feb., Mar., Apr., June, Sept., Oct., Nov.
Cardinal Machine Co.—June, Sept., Dec.
Carlton Machine Tool Co., The—Mar., Apr., May, June
*Carpenter Steel Co., The—Jan., Feb., Aug., Oct., Dec.
*Carr Lane Mfg. Co.—Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Nov., Dec.
*Cawi Machine Co., The—Feb., Mar., Apr., May
Central Safety Equipment Co.—Feb., Apr., June, Aug., Oct.
*Cerro de Pasco Sales Corp.—Jan., Apr., May, July, Aug., Sept., Nov.
*Challenge Machinery Co.—Jan., Mar., Apr., Oct.
*Champion Pneumatic Machinery Co.—Jan.
*Charmilles Eng. Works, Inc.—Apr.
Chaso Tool Co.—Feb., May, Oct.
Chicago-Latrobe—Jan., Mar., May
*Chicago Pneumatic Tool Co.—Apr., May, July, Sept.
Chicago Rivet & Machine Co.—Feb., Apr., June, Aug., Oct., Dec.
*Chicago Tramrail Corp.—Apr.
Ciba Co., Inc.—May
Cincinnati Bickford Division, Giddings & Lewis Machine Tool Co.—Jan., Dec.
Cincinnati Grinders, Inc.—Jan., Feb., Mar., Apr., May, June, July, Aug., Sept.
Cincinnati Milling Machine Co., Heald Machine Co., Subs.—Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Nov., Dec.
*Cincinnati Milling Machine Co., Meta-Dynamics Div.—Apr., Sept., Nov.
Cincinnati Milling Machine Co., Process Machinery Div.—Feb., Mar., June
Cincinnati Shaper Co.—Feb., Apr., Sept., Nov.
*Circular Tool Co.—Jan., Feb., Apr., June, Aug., Oct., Dec.
*Clark, Robert H., Co.—Feb.
*Clausing Div. Atlas Press Co.—Jan., Feb., Apr., May
Clearing Machine Corp., Div. U. S. Industries, Inc.—Jan., Mar., Apr., May, Aug., Oct.
*Cleco Div., Reed Roller Bit Co.—Apr.
Cleveland Grinding Machine Co., The—Mar., Apr., May, July, Oct., Nov., Dec.
Cleveland Hobbing & Machine Co.—Nov.
*Cleveland Instrument Co., Inc.—Feb., Mar., Apr., May, June, Sept., Oct., Nov.
Cleveland Tool & Die Co., The—Mar., Apr., May, July, Oct., Nov.
Cleveland Twist Drill Co.—Jan., May, Sept., Nov., Dec.
Clevite Corp., Brush Instruments Div.—Oct., Dec.
Clipper Diamond Tool Co.—Apr.
Coast Mfg. & Supply Co.—Jan.
*Cogsdill Tool Products, Inc.—Apr.
*Columbia International Corp.—Mar.
Columbia Tool Steel Co.—Jan., Mar.
*Commander Mfg. Co.—Apr.
Commando Tool Co.—Apr.
Composite Forgings, Inc.—Jan.
Cone Automatic Machine Co.—Jan., Feb.
Cone Automatic Machine Co., Pilot Div.—Feb., Apr., June, Aug.
*Connecticut Tool & Eng. Co.—Apr.
Continental Tool Works Div., Ex-Cell-O Corp.—Feb.
*Coromant Div., Sandvik Steel, Inc.—Feb., Mar., Apr., Sept., Oct., Dec.
Cosa Corp.—Jan., Mar., Apr., June, Sept., Nov.
*Crafts, Arthur A., Co., Inc.—Jan., Mar., Apr., May, July, Sept., Nov.
Crane Packing Co.—Feb., Mar., Sept., Oct., Nov.
Cratex Mfg. Co.—Sept.
*Crodian & Co.—Apr.
Cross Co., The—Jan., Feb., Mar., Apr., June, Sept., Oct., Dec.
Crucible Steel Co. of America—Jan.
*Crystal Lake Grinders—Apr.
*Cushman Chuck Co.—Feb., Apr., June, Aug., Sept., Nov.
*Cutter Div., The Ingersoll Milling Machine Co.—Apr., May, Nov., Dec.

D

*Danly Machine Specialties, Inc.—Dec.
Danneman Die Set Div., Acme-Danneman Co.—Jan., Mar., Apr.
*Darco Industries, Inc., Pacific Gage Div.—Feb., Mar., Apr.
*Davis Boring Tool Div., Giddings & Lewis Machine Tool Co.—Apr.
Dayton Rogers Mfg. Co.—Feb., Apr., July, Sept.
*Dazor Mfg. Corp.—Jan., Mar., May, July, Sept., Nov.
Dearborn Gage Co., Ellstrom Standards Div.—Sept.
DeBeers Consolidated Mines—Apr.
Delpark Industrial Filtration Co.—Jan., Mar., May, July
*Denison Eng. Div., American Brake Shoe Co.—Mar., Apr., July, Aug., Sept., Nov.
Detroit Mold Eng. Co.—Apr.
*Detroit Reamer & Tool Co.—Feb., Apr., June, Aug.
*Detroit Stamping Co.—Mar., July, Sept.
*Devcon Corp.—Mar., Apr., May, July, Sept., Nov.
*DeVlieg Microbore Div., DeVlieg Machine Co.—Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Nov., Dec.
DeVlieg Machine Co., Jigmill Div.—Feb., Apr., June, Aug., Oct., Dec.
Diamond Research Laboratory—Apr.
Diamond Tool Research Co.—Apr., May
Dickerman, H. E., Mfg. Co.—Jan., Mar., May, June, Sept., Nov.
*DoALL Co.—Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Nov.
*Doerr Electric Corp.—Apr.
Donley Products, Inc.—Dec.
*Dow Chemical Co., The—Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Nov., Dec.
Dukes Co.—June, July
Dumore Co., The—Mar., Apr., June, Oct., Dec.
Dykem Co., The—Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Nov., Dec.

E

Eastern Machine Screw Corp., The—Mar., Apr., Aug., Sept., Nov.
*Eastman Kodak Co.—Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Nov., Dec.
*Eclipse Counterbore Co.—Feb., Apr., May, July, Sept., Oct., Nov.
Edlund Machinery Co.—Feb., Apr., Sept.
Ehrhardt Tool & Machine Co.—Feb., Apr., May, July, Sept.
Electro-Autosizing Machine Corp.—Apr., June, Sept.
*Electronic Control Systems, Inc.—Sept.
Ellstrom Standards Div., Dearborn Gage Co.—Sept.
*Elox Corp. of Michigan—Mar., Apr.
*Engelberg-Huller Co., Inc., The—Jan., Mar., Apr., Aug., Sept., Dec.
*Erickson Tool Co.—Mar., Apr., Oct.
Ernest, Holdeman & Collett, Inc., Speed-grip Chuck Div.—Jan., Mar., Apr., May, July, Sept., Nov.
*Errington Mechanical Labs, Inc.—Apr.
Ettco Tool & Machine Co., Inc.—Sept., Nov.
Ex-Cell-O-Corp.—Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Nov., Dec.
Ex-Cell-O Corp., Continental Tool Works Div.—Feb.

F

Famco Machine Co.—Jan., Mar., June, Nov.
Federal Products Corp.—Feb., Apr., June, Sept., Oct., Dec.
Feedall, Inc.—Sept.
*Fellows Gear Shaper Co.—Jan., Mar., Apr., July, Sept., Nov.
*Firth-Sterling, Inc.—Feb., Apr., June, Sept., Nov.
Fiske Bros. Refining Co.—Feb., Apr., June, Aug., Oct., Dec.
*Flick-Reedy Corp., Miller Fluid Power Div.—Feb., Mar., Apr., June, July, Sept.
Foote-Burt Co.—Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Nov. Dec.
Ford, M. A. Mfg. Co.—Feb., Apr., Sept., Oct.
Foredom Electric Co.—Nov.
Freeland Gauge Co.—June
Furane Plastics, Inc.—Apr.

G

Gaertner Scientific Corp.—Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Nov., Dec.
*Galland-Henning Mfg. Co., Nopak Div.—Feb., Apr., June, Aug., Oct., Dec.
*Gammons-Hoaglund Co.—Jan.
Gardner-Denver Corp., Keller Tool Div.—Jan., Feb., Mar., Apr., May, June, July, Oct., Dec.
Gatco Rotary Bushing Co.—Jan., Mar., May, July, Sept., Nov.
*General American Transportation Corp., Parker-Kalon Div.—Jan., Apr., May, July, Sept., Nov., Dec.
*General Electric Co., Metallurgical Products Dept.—Feb., Mar., May, July, Sept., Nov.
General Industrial Diamond Co.—Apr.
General Motors Corp., Oldsmobile Div.—Feb., Apr., June, Aug., Dec.
Geometric-Horton—Apr.
*George, James W., Machinery Co.—Apr.
Giddings & Lewis Machine Tool Co., Cincinnati Bickford Div.—Jan., Dec.
*Giddings & Lewis Machine Tool Co., Davis Boring Tool Div.—Apr.
*Gilman, Russell T., Co.—Apr.
Gisholt Machine Co.—Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Nov., Dec.
Glenzer, J. C., Co.—Sept., Nov.
Golconda Corp., Div. of Super-Cut, Inc.—Apr.
Gorton, George, Co.—Jan., Feb., Apr., Sept., Oct., Nov.
Greaves Machine Tool Co.—Jan., Mar., July, Aug., Sept., Dec.
*Green Instrument Co.—Jan., Mar., Apr.
Greenfield Tap & Die Corp.—Apr., May, July, Sept., Nov.
Greenfield Tap & Die Corp., Horton Chuck Div.—Jan., Feb., Mar., June, July
Greenlee Bros. & Co.—Feb., Apr., July, Aug., Sept., Oct., Nov., Dec.
*Grob, Inc.—Jan., Feb., Mar., Apr., May, June
*Grobet File Co. of America, Inc.—Apr.
*Gulf Oil Co.—Mar., Nov.

H

Hall Mfg. Co—Mar., May, July
*Hammond Machinery Builders, Inc.—Mar., Apr., Dec.
*Handy & Harman—Feb., Apr., June, Aug., Sept., Nov.
*Hanna Eng. Works—Aug., Nov.
Hannifin Co., Div. Parker-Hannifin Corp.—Jan., Apr., Nov., Dec.
Hanson-Whitney Div., Whitney Chain Co.—Feb., Mar., May, July, Sept., Nov., Dec.
Hardinge Brothers, Inc.—Jan., Feb., Mar., Apr., May, June, Aug., Sept., Oct., Nov., Dec.
Hartford Special Machinery Co.—Mar., Apr., May, June, July, Aug.
Hastings Chemical Div., Minnesota Mining & Mfg. Co.—Mar., Apr.
Heald Machine Co., Subs., Cincinnati Milling Machine Co.—Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Nov., Dec.
*Heinrich Tools, Inc.—Jan., Apr.
*Heller Tool Co., Subs., Simonds Saw & Steel Co.—Feb., Mar., Apr., May, June, Sept., Oct., Nov.
Hendey Machine Div., Barber-Colman Co.—Sept., Oct., Nov., Dec.
High Standard Mfg. Corp., The—June, Aug., Sept.
Hill Machine Co.—Sept.
*Homestrand, Inc.—Apr.
Horton Chuck Div., Greenfield Tap & Die Co.—Jan., Feb., Mar., Apr., June, July
*Huron Machine Products—Sept.
Hy-Pro Tool Co.—Apr., May, Aug., Oct., Nov., Dec.

I

*Ideal Industries, Inc.—Feb., Mar., May, July, Sept.
*Illinite Div., Illinois Tool Works—Mar., Apr.
Illinois Institute of Technology—Apr., May
Industrial Distributors, Inc.—Apr., Oct.
Industrial Filtration Co., Delpark Div.—Jan., Mar., May, July
*Industrial Tectonics, Inc.—Oct., Dec.
*Ingersoll Milling Machine Co., The, Cutter Div.—Jan., Feb., Apr., May, Nov., Dec.
*Ingersoll-Rand Co.—Apr.
Invo-Spline, Inc.—July

J

*Jacobs Mfg. Co.—Mar., May., Sept., Oct.
Jahn, B., Mfg. Co., The—Feb., Apr., June, Aug., Oct., Dec.
*Jarvis Corp., The—Feb., Apr., May, Sept., Oct., Dec.
*Jergens Tool Specialty Co.—May, Oct.
*Jersey Mfg. Co.—Jan., Feb., Apr., Sept., Nov.
*Jiffy Mfg. Co.—Apr.
Jigmill Div., DeVlieg Machine Co.—Feb., Apr., June, Aug., Oct., Dec.
*Jones & Lamson Machine Co.—Apr., June
Jones Motrola Corp.—Dec.
Joslyn-Hudson Co.—Feb., May, Aug.

K

KDK Products—Sept., Oct., Nov.
Kasenit Co.—Apr.
Kaufman Mfg. Co.—Apr., June, Sept.
Kearney & Trecker Corp.—Jan., Mar., Apr., June, Aug., Sept., Oct.
Keller Tool Div., Gardner-Denver Corp.—Jan., Feb., Mar., Apr., May, June, July, Oct., Dec.
*Kennametal, Inc.—Jan., Mar., Apr., June, July, Aug., Sept., Oct., Nov., Dec.
*King Tester Corp.—Jan., Apr.
Kingsbury Machine Tool Co.—Apr.
*Klingelhofer Machine Tool Corp.—Apr.
*Kurt Orban Co.—Feb., Mar.

L

L-W Chuck Co.—Mar., June
*Lamina Dies & Tools, Inc.—Jan., Apr., May, July, Sept., Nov.
*Lapeer Mfg. Co.—Feb., Apr., June, Aug., Sept., Dec.
Lapointe Machine Tool Co.—Feb., Apr., June, Sept., Oct.
Lavallee & Ide, Inc.—Jan., Feb., Mar., Apr., May
*Lee, K. O., Co.—Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Nov., Dec.
Lees-Bradner Co.—Mar., Apr., June, Sept., Nov.
*Leland-Gifford Co.—Feb., Apr., June, Aug., Oct., Dec.
Lempco Industrial, Inc.—Feb.
Lepel High Frequency Labs—Feb., Apr., June, Aug., Oct., Dec.
*Levin, Louis & Son, Inc.—Jan., Mar., May, July, Sept.
Lewis Machine Co., Inc.—Apr.
Lilly, Eli, & Co.—Oct., Nov., Dec.
Lincoln Electric Co.—Mar., Apr., June, Sept., Oct., Nov.
Lindberg Eng. Co.—Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Dec.
Link Aviation, Inc.—Mar.
Littell, F. J., Machine Co.—Jan., Mar., May, Sept.
*Livernois Eng. Co.—Apr.
*Lodding, Inc.—Feb., Apr., June, Aug., Oct., Dec.
*Logansport Machine Co.—Feb., Apr., June, Aug., Oct., Dec.
*Lovejoy Tool Co.—Feb., Apr., June, Aug., Sept.
*Lufkin Rule Co.—Apr., June, Sept., Oct., Nov.

M

*Mac-It Screw Div., Strong-Carlisle-Hammond—Jan.
Macklin Co.—Jan.
*Madison-Faessler Tool Co.—Oct.
Magna-Driver Corp.—Apr., May, June
Magnetics, Inc.—Mar., Apr., June, Aug., Oct., Dec.
*Man-au-Cycle Corp. of America—Sept.
*Manex Machinery Corp.—Apr.
Manhattan Rubber Div., Raybestos-Manhattan, Inc.—Jan., Feb., Mar., Apr., Oct., Dec.
Marcellus Mfg. Co.—Apr., June, Aug.
Marshall Steel Co.—May, Sept., Oct.
*Master Chemical Co.—Apr.
*Mayline Co.—Jan., Mar., Apr., July, Sept., Nov.
*M-B Products Corp.—Apr.
*McCrosky Tool Corp.—Mar., Apr., Sept.
McKay Machine Co.—Feb., Apr., June, Aug., Oct., Dec.
Mechanische Werkstatten—Jan.
Melin Tool Co., Inc.—Feb., Apr., June
*Metallurgical Products Dept., General Electric Co.—Feb., Mar., May, July, Sept., Nov.
*Metal Carbides Corp.—Jan., Mar., May, July, Sept., Nov.
Mettler Machine Co.—Feb., Mar.
Meyers, W. F., Co.—Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Nov., Dec.
Michigan Tool Co.—June, Sept., Oct., Nov.
*Micrometrical Mfg. Co.—Feb., June, Aug., Oct., Dec.
Midwest Gage Laboratory, Div. of American Gage & Machine Co.—Apr.
*Milford Rivet & Machine Co.—Jan., Feb., Mar., Aug., Sept., Dec.
Miller Co., The—June, Sept., Nov.
*Miller Fluid Power Div., Flick-Reedy Corp.—Feb., Mar., Apr., June, July, Sept.
Miller, Harry, Corp.—Mar., June, Sept.
Milne, A., & Co.—Feb., Mar., Sept.
Minnesota Mining & Mfg. Co.—Mar., Apr., June, Oct., Nov., Dec.
*Modernair Corp.—Feb., Apr., June, Aug., Oct., Nov.
*Mohawk Tools, Inc.—Jan., Mar., May, July, Sept., Nov.
Momar Industries, Inc.—Jan., Feb.
Monarch Aluminum Mfg. Co.—Feb., Mar., Apr., June
Monarch Machine Tool Co.—May
Montgomery & Co., Inc.—June, Nov.
*Moore Special Tool Co.—Apr., June, Sept., Nov.
*Morris, Robert E., Co.—Mar., May, July, Nov.
*Morse, H. E., Co.—Apr.
Morse Twist Drill & Machine Co., Subs. Van Norman Industries, Inc.—Jan., Feb., Apr., June, Aug., Oct.
*Motch & Merryweather Machinery Co.—Feb., Mar., Apr., June, Aug., Oct., Dec.

N

*National Acme Co., The—Feb., Mar., Apr., May, June, Aug., Sept., Oct., Nov.
National Automatic Tool Co., Inc.—Jan., Feb.
*National Broach & Machine Co.—Jan., Feb., Mar., Apr., May, June, Sept., Nov.
*National Pioneer, Inc.—Sept.
National Tool Co.—Jan., Mar.

National Twist Drill & Tool Co.—Feb., Apr., June, July, Aug., Oct., Dec.
*Nelco Cutting Tool Div., Brown & Sharpe Mfg. Co.—Feb., Mar., May, June, Sept., Nov.
New Britain Machine Co., The—Jan., Feb., Mar., Apr., May., June, July, Aug., Sept., Oct., Nov., Dec.
Newcomer Products, Inc.—Apr.
New York Twist Drill Co.—July
Niagara Machine & Tool Works—Jan., Mar., Apr.
Nice Ball Bearing Co.—Feb., Apr., Sept.
*Nikon, Inc.—Feb., Apr., June, Aug., Sept.
*Nilson, A. H., Machine Co., The—Feb., Apr., June, Sept., Oct., Dec.
*Nopak Div., Galland-Henning Mfg. Co.—Feb., Apr., June, Aug., Oct., Dec.
Norgren, C. A., Co.—Jan., Mar., Apr., June, Oct., Dec.
*Northwestern Tools, Inc.—Jan., Mar., Apr., July, Sept., Nov.
Norton Co., Abrasive Grinding Wheels Div.—Jan., Mar., May, June, Sept., Oct., Nov.
Norton Co., Machine Div.—Feb., Apr., May, Sept., Oct., Nov., Dec.

O

*Oakite Products, Inc.—Jan., Feb., Mar., Apr., June, July, Sept., Oct., Nov.
*Ohio Crankshaft Co., Inc.—Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Nov., Dec.
O. K. Tool Co., Inc., The—Jan., Feb., Apr., May, Sept.
Oldsmobile Div., General Motors Corp.—Feb., Apr., June, Aug., Dec.
*Olivetti Corp. of America, Machine Tool Div.—Feb., Apr., June, Sept., Oct., Dec.
Olkon Corp.—Feb., Apr., June, Aug., Oct., Dec.
Olofsson Corp.—Jan., Apr., June, Aug.
*Olsen, Tinius, Testing Machine Co.—Feb., Apr., June, Aug., Oct., Dec.
Onsrud Machine Works, Inc.—Feb., Mar., Apr., June, Oct., Dec.
*Optical Gaging Products, Inc.—Jan., Mar., June
*Opto-Metric Tools, Inc.—Feb., Mar., Apr., May, July, Oct., Dec.
*Orban, Kurt, Co.—Feb., Apr., Sept., Oct.
*Ortman-Miller Machine Co.—Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Nov., Dec.
*Osborn Mfg. Co.—Jan., Mar., May, July, Sept., Nov.

P

*PIC Design Corp.—May
*Pacific Gage Div., Darco Industries, Inc.—Mar., Apr.
*Pacific Industrial Mfg. Co.—Jan., Feb., Mar., Apr., July, Sept., Nov., Dec.
Pangborn Corp.—Feb.
Paramount Tooling Co.—Sept.
Parker-Hannifin Corp., Hannifin Co., Div.—Nov., Dec.
*Parker-Kalon Corp., Div., General American Transportation Co.—Jan., Apr., May, July, Sept., Nov., Dec.
Parker-Majestic, Inc.—Jan., Mar., June
Parkwood Laminates, Inc.—Apr., May, June, July, Sept., Oct.
*Penn Eng. & Mfg. Co.—Feb.
*Perry Equipment & Eng. Co., Div. Automation Devices, Inc.—Mar., Apr., May, June, Aug., Sept., Nov., Dec.
*Petz-Emery, Inc.—Apr., May, July, Sept.
Pilot Div., Cone Automatic Machine Co.—Feb., Apr., June, Aug.
*Pines Engineering Co., Inc.—Jan., Mar., Apr., June, Sept., Nov.
*Pioneer Aluminum, Inc.—Feb., Apr., June, Aug., Oct., Dec.
Pioneer Tool & Engineering—Sept.
Pipe Machinery Co.—Jan., Feb., Mar., Apr., May, June, Aug., Oct., Dec.
Pittsburgh Tool Steel Wire Co.—May
Polish Products (Varimex, Ltd.)—Sept., Oct., Nov.
Pope Machinery Corp.—Jan., Feb., Mar., Apr., May, June, Sept., Oct., Nov.
Porter, H. K., Co., Vulcan Crucible Steel Div.—Feb., Apr.
Potter & Johnston Co., Div. Pratt & Whitney Co., Inc.—Feb., Apr., June, July, Sept., Nov.
Pratt & Whitney Co., Inc.—Feb., Apr., July, Sept., Nov.
*Precision Tool & Mfg. Co.—Jan., Feb., Apr., May
Producto Machine Co., The—Jan., Feb., Mar., Apr., June, Sept., Oct., Dec.
*Punch Products Corp.—Dec.
Putnam Tool Co.—Feb., Apr., June, Aug., Oct.

Q

*Queen Products, Inc., Almco Div.—Jan., Mar., Apr., June, Sept., Nov.

R

*R and L Tools, Inc.—Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Nov., Dec.
*Rahn Granite Surface Plate Co.—Apr.
Raybestos-Manhattan, Inc., Manhattan Rubber Div.—Jan., Feb., Mar., Apr., Oct., Dec.
Reed Rolled Thread Die Co.—Jan., Mar., Apr., June, Sept., Nov.
*Reed Roller Bit Co., Cleco Div.—Apr.
*Reichhold Chemicals, Inc.—Feb., Apr., June, Aug., Oct., Dec.
Renaud Plastics, Inc.—Feb., Mar.
Republic Aviation—June
*Retor Developments, Inc.—Apr.
*Richard Bros. Punch Div., Allied Products Corp.—Feb.
*Richards, J. A., Co.—Mar., Apr.
Ring Punch & Die Co., Inc.—Feb., Apr., June, Oct., Dec.
Rivett Lathe & Grinder Co., Inc.—Jan., Mar., May
*Robbins, Omer E., Co.—Feb., Apr., June, Aug., Oct., Dec.
*Robinson Aviation, Inc.—Apr.
Rockford Clutch Div., Borg-Warner Corp.—Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Nov., Dec.
Ronald Press Co.—June
*Ross Operating Valve Inc.—Apr.
*Rotor Tool Co.—Feb., Apr.
Royco Tap & Tool Co.—Apr., Sept.
*Russell, Holbrook & Henderson, Inc.—Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Nov., Dec.
*Ryerson, Jos. T., & Son, Inc.—Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Nov., Dec.

S

*S & S Machinery Corp.—Sept.
*Sandvik Steel, Inc., Coromant Div.—Feb., Mar., Apr., Sept., Oct., Dec.
*Scharmann Machine Corp.—Apr.
*Scherr, Geo., Co.—Feb., Apr., June, Sept., Oct., Dec.
*Schrader's, A. Son—Jan., Feb., Mar., May, Sept., Nov.
Schrillo Aero Eng. Co.—Mar., May
Scientific Electric Co.—May, June, Sept.
*Scully-Jones & Co.—Apr., May, June, Sept., Nov., Dec.
*Sealol Corp.—Feb., Mar., May
*Seewald, Inc.—Apr.
*Seibert & Sons, Inc.—Jan., Mar., May, July, Sept., Nov.
Sema Corp.—Apr., Sept.
Seneca Falls Machine Co.—Jan., Feb., Mar., Apr., May, June, Sept., Oct.
*Service Machine Co.—Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Nov., Dec.
Sesco, Inc.—Apr.
Severance Tool Industries, Inc.—Jan., Mar., May, July, Sept., Nov.
Shaker Tool & Die Co.—Aug., Sept., Oct.
*Sheffield Corp., The—Jan., Feb., Apr., June, Nov., Dec.
*Sheldon Machine Co.—Jan., Feb., Mar., Apr., May, June, Sept., Oct., Nov., Dec.
Shell Chemical Corp.—Apr., June, Aug., Oct.
Shell Oil Co.—Aug., Sept., Oct., Nov
*Sheppard, Stanley—Mar., Apr.
Sidney Machine Tool Co., Buhr Machine Tool Co., Subs.—Mar., Oct., Nov.
*Sigma Corp.—May, Sept.
Silber Products, Inc.—Apr.
*Simonds Abrasive Co.—Feb., Apr., June
*Simonds Saw & Steel Co.—Jan., Feb., Mar., Apr., May, June, Oct.
*Simonds Saw & Steel Co., Heller Tool Co., Subs.—Feb., Mar., Apr., May, June, Sept., Oct., Nov.
Simplex Machine Tool Corp.—Jan.
*Simpson Electric Co., Ind. Div., American Gage & Machine Co.—Jan., Apr.
Sinclair Refining Co.—Mar., Apr., May, Sept., Oct., Nov.
*Size Control Co., Ind. Div., American Gage & Machine Co.—Jan., Apr.
*Skinner Chuck Co., The—Mar., May, June
Smit, J. K., & Sons, Inc.—Jan., Apr.
Snow Mfg. Co.—Jan., Mar., Oct.

Snyder Tool & Eng. Co.—Jan., Mar., May, July
Somma Tool Co., Inc.—Apr.
Sonnet Tool & Mfg. Co.—June
Sossner Tap & Tool Co.—Jan., Feb., Apr., May, Oct., Dec.
Southwest Products Co.—Feb., Apr., June, Aug., Oct., Dec.
S-P Mfg. Corp.—Jan., Feb., Apr.
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*Spittler, Henry A., Co., Inc.—Apr.
*Standard Electrical Tool Co.—Jan., Apr.
Standard Gage Co., Inc.—Jan., Feb., Mar., Apr., May, June
*Standard Parts Co.—Jan., Mar., May, Sept., Oct., Nov.
*Standard Pressed Steel Co.—Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Nov., Dec.
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Standard Transformer Co.—Jan.
Staples Tool Co.—Jan., Mar., May, July, Sept., Nov.
*Starlite Industries, Inc.—Apr.
*Starrett, L. S., Co., The—Jan., Feb., Mar., Apr., May, Sept., Oct., Nov., Dec.
Stau, E. H., Co.—Jan.
*Stone Machinery Co.—Mar., Apr., Aug., Dec.
*Strong, Carlisle, Hammond, Mac-It Screw Div.—Jan.
Stuart, D.A., Oil Co., Ltd.—Jan., Mar., May, Nov.
Sturtevant, P. A., Co.—Jan., Mar.
*Sun Oil Co.—Jan., Feb., Mar., Apr., May, June, July, Aug., Sept.
Sundstrand Machine Tool Co.—Feb., Apr., June, Aug., Dec.
*Sunnen Products Co.—Feb., May, Sept.
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Super Tool Co., Div. Van Norman Industries, Inc.—Jan., Feb., Apr., May, Sept., Nov.
*Superior Hone Corp.—Feb., Apr.
*Superior Pneumatic & Mfg. Co.—Apr.
Superior Steel Products Corp.—Feb., Apr., June, Aug., Sept., Oct.
*Supreme Products Co.—Jan., Apr., Sept.
*Sykes Machine & Gear Corp.—Apr., Sept., Nov., Dec.
*Syntron Co.—Feb., Mar., Apr., June, Sept., Oct.

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*Taylor Devices, Inc.—Apr.
Techline Div., Wheelabrator Corp.— Sept.
*Techno Products Co.—Sept.
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*Thor Power Tool Co.—Mar., May, June, Aug., Sept.
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*Tomkins-Johnson Co.—Feb., Apr., June, Aug., Oct., Dec.
*Torit Mfg. Co.—Feb., Apr., June, Aug.
*Torrington Co.—Apr.
Torrington Mfg. Co.—Mar., Apr., June, Sept., Oct., Nov.
*True-Trace Sales Corp.—Sept.
*Tubular Rivet & Stud Co.—Apr.

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*Uddeholm Co. of America, Inc.—Feb., Apr., June, Sept., Oct., Dec.
*Unimat Div., American Edelstaal—July, Sept.
Union Carbide Corp., Bakelite Co., A Div.—May, Sept., Dec.
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*U. S. Gypsum Co.—Dec.
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*U. S. Tool Co., Inc.—Jan., Feb., Apr., June Aug., Oct.
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Universal Eng. Co.—Feb., Apr., June, Aug., Oct., Dec.

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*Vernon Devices, Inc.—Apr.
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*Vlier Engineering, Inc.—May, July, Sept., Nov.
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*Vulcan Tool Co.—Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Nov., Dec.

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*Wadell Equipment Co.—Apr.
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December 1958

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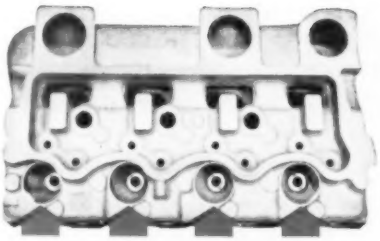
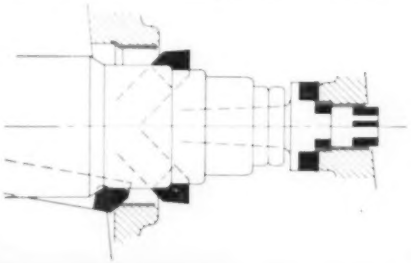


MACHINES 21 CYLINDER HEAD SURFACES IN ONE PASS WITH DEPTH OF CUT BETWEEN 1/8" AND 3/16"
Rough castings are bored, plunge-faced and chamfered at a rate of 18 parts per hour. Tooling is shown below.



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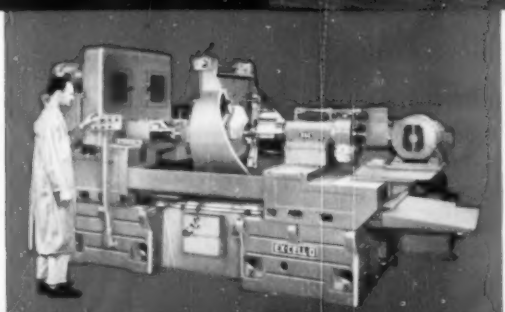
RIGHT: Style 771 machines both 4-and-6-cylinder tractor components. As cycle starts, table rapids to left, spindles rotate and feed traverse begins. At end of stroke, table rapids out to clear tooling; fixture indexes, cycle repeats for second set of holes.

BELOW: Double-end Style 772 performs multiple machining operations on tractor gear case cover.



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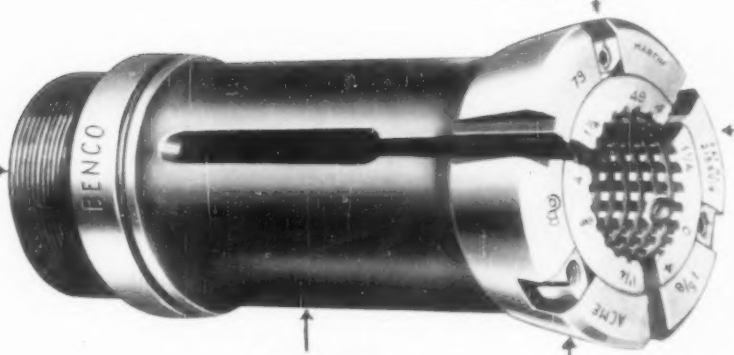
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